Environmental Assessment
for
Improvements to the

I-195/Taunton Avenue/Warren Avenue Interchange
East Providence, Rhode Island

TECHNICAL MEMORANDUM NO. 1
TRAFFIC PROJECTIONS AND ANALYSIS

Rhode Island Department of Transportation
and the
U.S. Department of Transportation
Federal Highway Administration

September 2007

Environmental Assessment

for

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R.I. Federal Aid Project No. IM-0195(004)

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1.0 PROJECT DESCRIPTION

An Environmental Assessment (EA) has been prepared to address the potential impacts associated with improvements to the I-195/Taunton Avenue/Warren Avenue Interchange in East Providence, Rhode Island. The purpose of the project is to improve access to and from I-195 in this section of East Providence, improve traffic flow and safety in and around the interchange, and plan for projected growth and future transportation needs. The existing interchange currently provides movements only to and from the west on I-195. The EA evaluates a range of options including the no-build alternative, an upgrade/TSM alternative, and three build alternatives. All of the build alternatives involve adding two new ramps to the existing interchange to provide the missing traffic movements to and from the east. See Figure 1 for the study area.

This Technical Memorandum serves to summarize the traffic projections and analyses that were conducted for the I-195/Taunton Avenue/Warren Avenue Interchange Improvement Project. See Figure 2 for the traffic analysis area. Traffic projections and analyses are briefly described within the text of the Environmental Assessment. This Technical Memorandum provides more detail on the subject matter.

2.0 EXISTING TRAFFIC CONDITIONS

2.1 Existing Traffic Volumes

Existing traffic conditions were established by compiling available traffic count data and collecting additional count data, where necessary. A traffic count program was implemented for this project. The count program involved the collection of automatic traffic recordings (ATR) and manual turning movement counts (MTMC). See Figure 3 for the Traffic Count Locations.

ATR count data was provided by the Rhode Island Department of Transportation (RIDOT) at the following locations:

- Warren Avenue east of Route 114
- Taunton Avenue between I-195 Exit 5 and Grove Avenue
- Lyon Avenue Bridge over I-195
- Veterans Memorial Parkway between Warren Avenue and South Broadway.

Also, monthly count data collected by the Mobility Technology Radar Devices was provided along I-195 at three locations including:

- approximately one-quarter mile west of Exit 3,
- one-half mile west of Broadway, and

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STUDY AREA

SCALE: 1" = 600'

FIGURE 1

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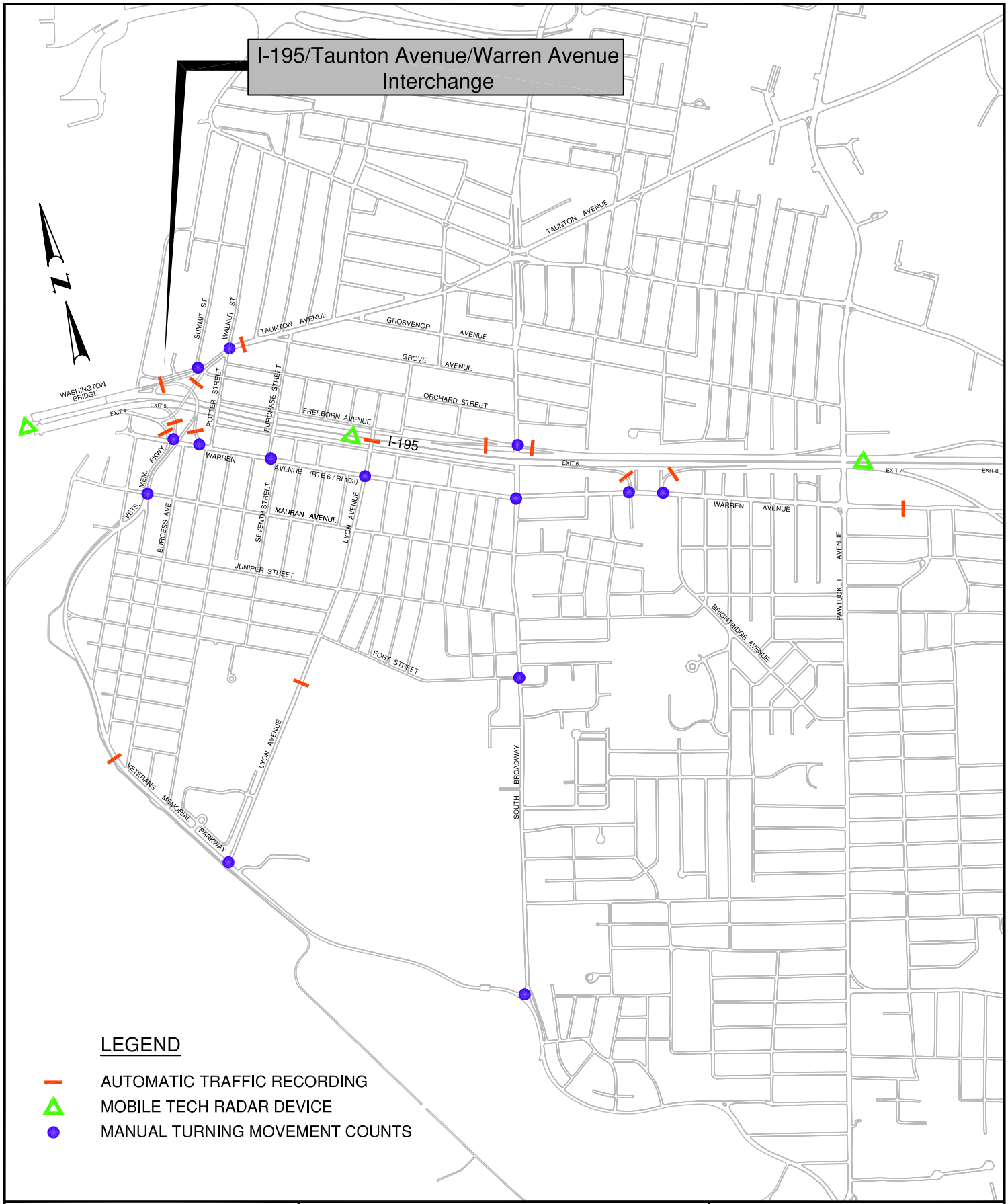
East Providence, Rhode Island

TRAFFIC ANALYSIS AREA

0 260 520 1,040 1,560 2,080 Feet

FIGURE 2



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East Providence, Rhode Island

TRAFFIC COUNT LOCATIONS

FIGURE 3

- 0.17 mile east of Pawtucket Avenue.

ATR counts were collected for a 48-hour period on weekdays at the following locations:

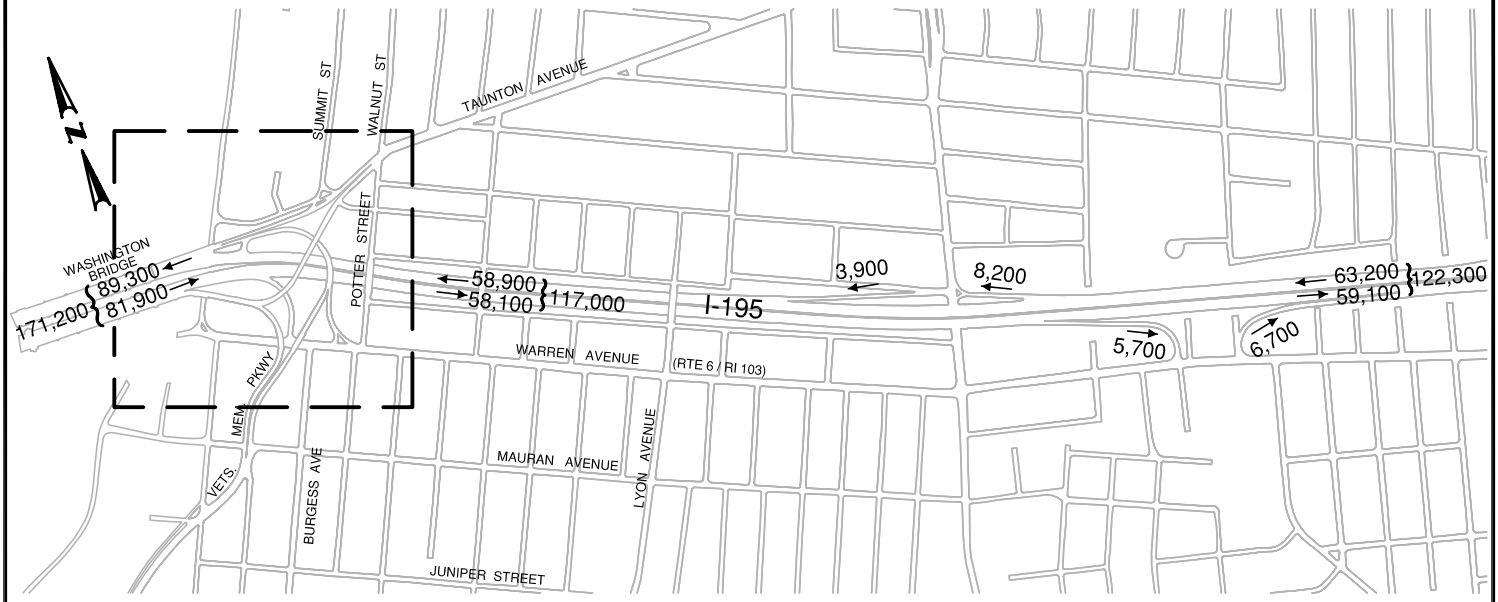
- I-195 WB on-ramp from Warren Avenue WB
- I-195 EB off-ramp to Warren Avenue
- I-195 EB off-ramp to Veterans Memorial Parkway
- I-195 WB on-ramp from Taunton Avenue & Veterans Memorial Parkway
- I-195 EB off-ramp to Taunton Avenue EB
- I-195 WB on-ramp from Broadway (Exit 6)
- I-195 WB off-ramp to Broadway (Exit 6)
- I-195 EB on-ramp from Warren Avenue (Exit 6)
- I-195 EB off-ramp to Warren Avenue (Exit 6)
- Lyon Avenue between Veterans Memorial Parkway and Warren Avenue

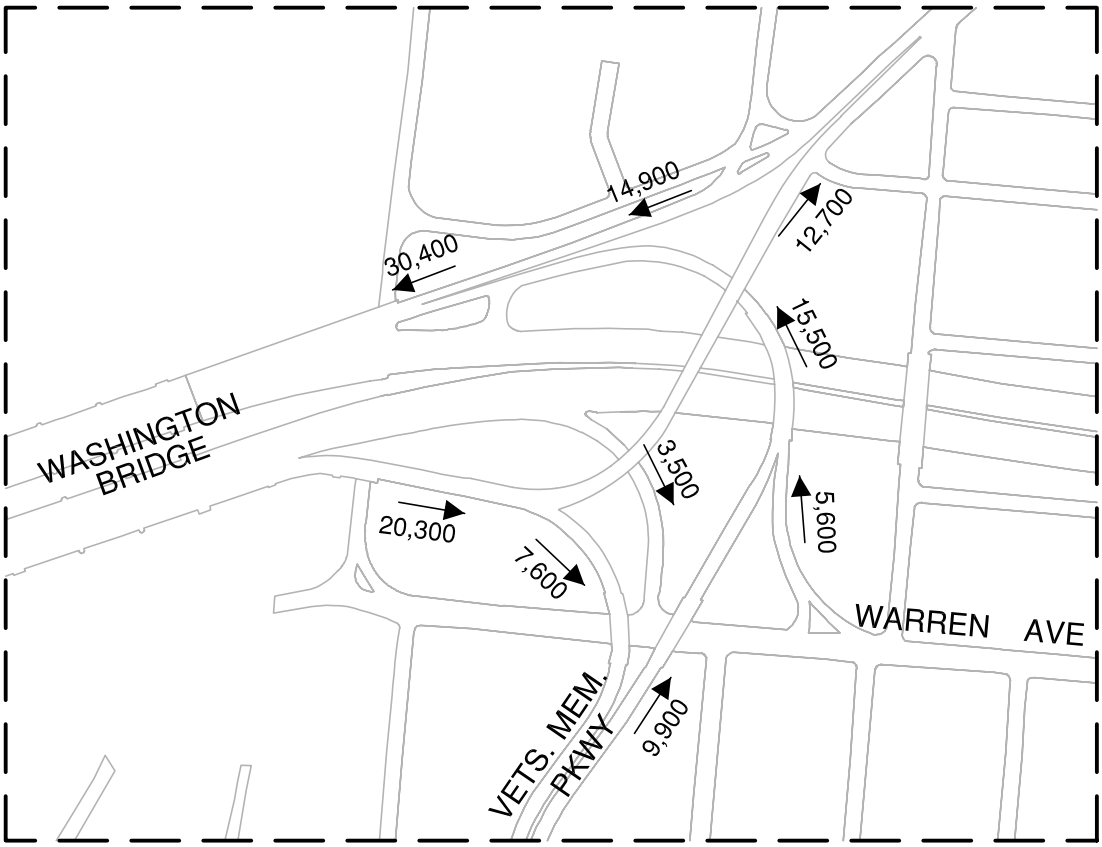
Manual turning movement counts (MTMCs) were taken at the fourteen intersections in November of 2004. At two locations, the MTMCs were collected for a 12-hour duration on a weekday. At the remaining locations, the counts were collected from 7-9 AM and 3-6 PM on a weekday. The count locations include:

- Taunton Avenue/Potter Street (12-hour count)
- Warren Avenue/Broadway (12-hour count)
- Warren Avenue/Purchase Street/Seventh Street
- Veterans Memorial Parkway/Mauran Avenue
- Veterans Memorial Parkway/Lyon Avenue
- Veterans Memorial Parkway/South Broadway
- Taunton Avenue/Summit Street
- Warren Avenue/Lyon Avenue
- Broadway/Fort Street
- Broadway/I-195 Ramps
- Warren Avenue/I-195 Ramps at Exit 5 (two intersections)
- Warren Avenue/I-195 Ramps at Exit 6 (Two intersections)

The count data collected for this study has been compiled into traffic flow maps to represent the existing traffic conditions. Traffic data was factored using RIDOT expansion factors to represent Average Annual Daily Traffic (AADT) volumes. Figure 4 shows the 2004 AADT Freeway Volumes and Figure 5 shows the 2004 AADT Intersection Volumes.

A system-wide peak hour was identified for the morning and the afternoon. For the morning, the peak hour occurred from 7:30-8:30. The AM peak hour traffic volumes are shown in Figure 6 for the freeway, and Figure 7 for the intersections. The afternoon peak hour occurred





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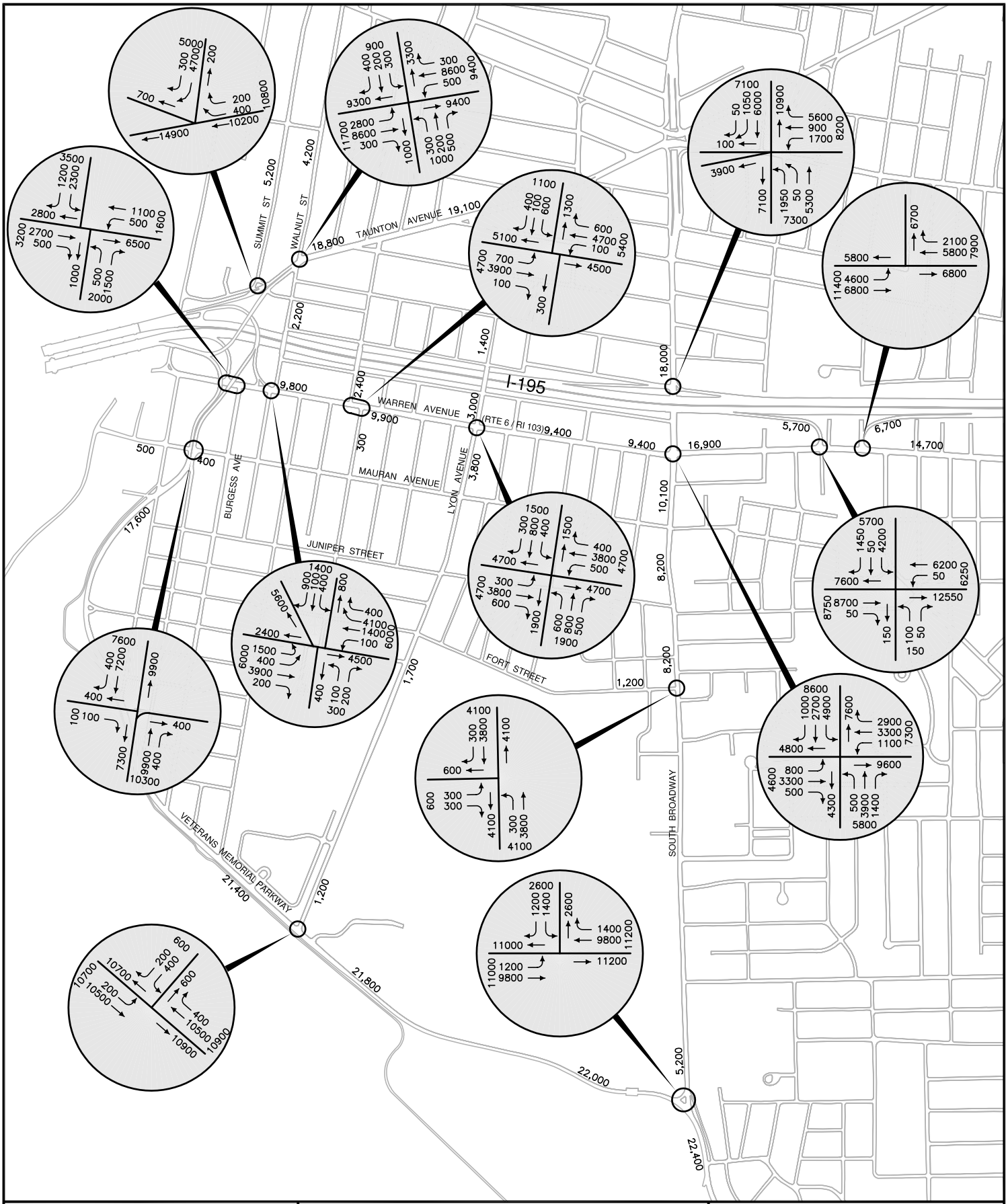
2004
AVERAGE ANNUAL
DAILY TRAFFIC
(AADT)
FREEWAY VOLUMES

FIGURE 4



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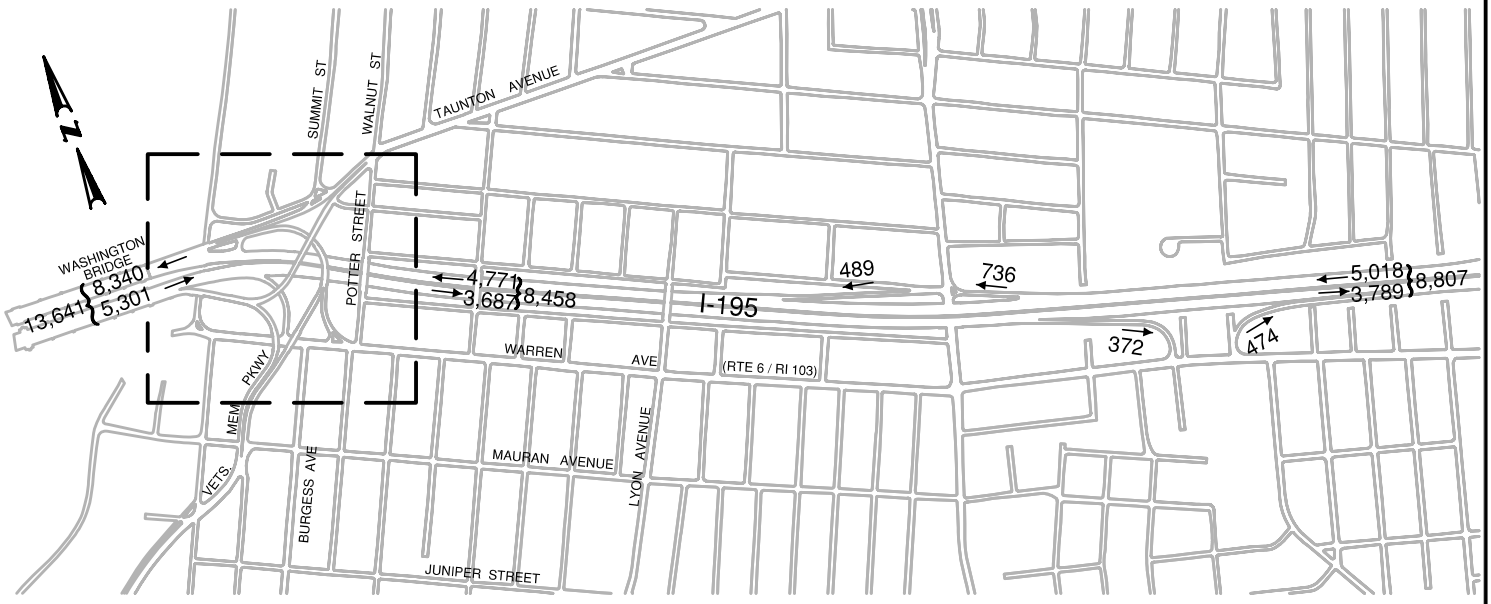
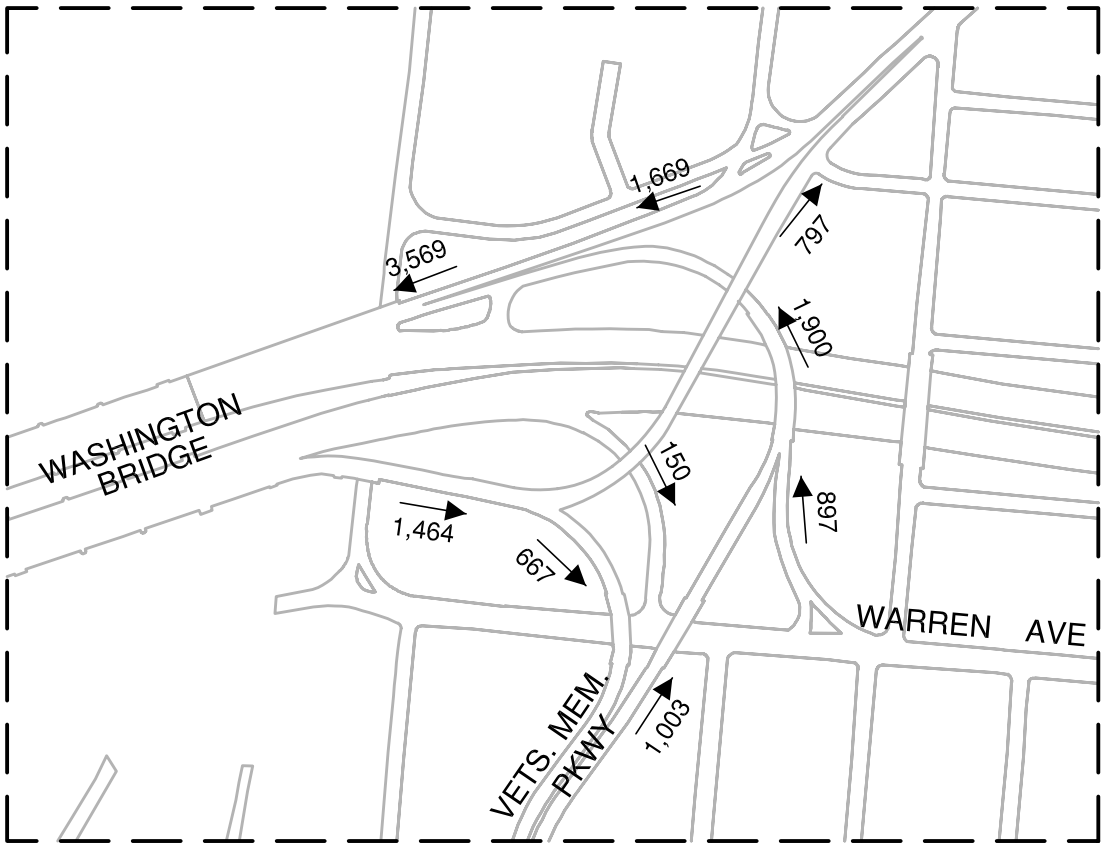
2004
AVERAGE ANNUAL
DAILY TRAFFIC
(AADT)
INTERSECTION VOLUMES

FIGURE 5





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2004
AM PEAK HOUR
7:30 - 8:30
FREEWAY VOLUMES

FIGURE 6

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2004
AM PEAK HOUR
7:30 - 8:30
INTERSECTION VOLUMES

FIGURE 7

between 4:30 and 5:30 PM and is shown in Figures 8 and 9 for the freeway and intersection volumes, respectively.

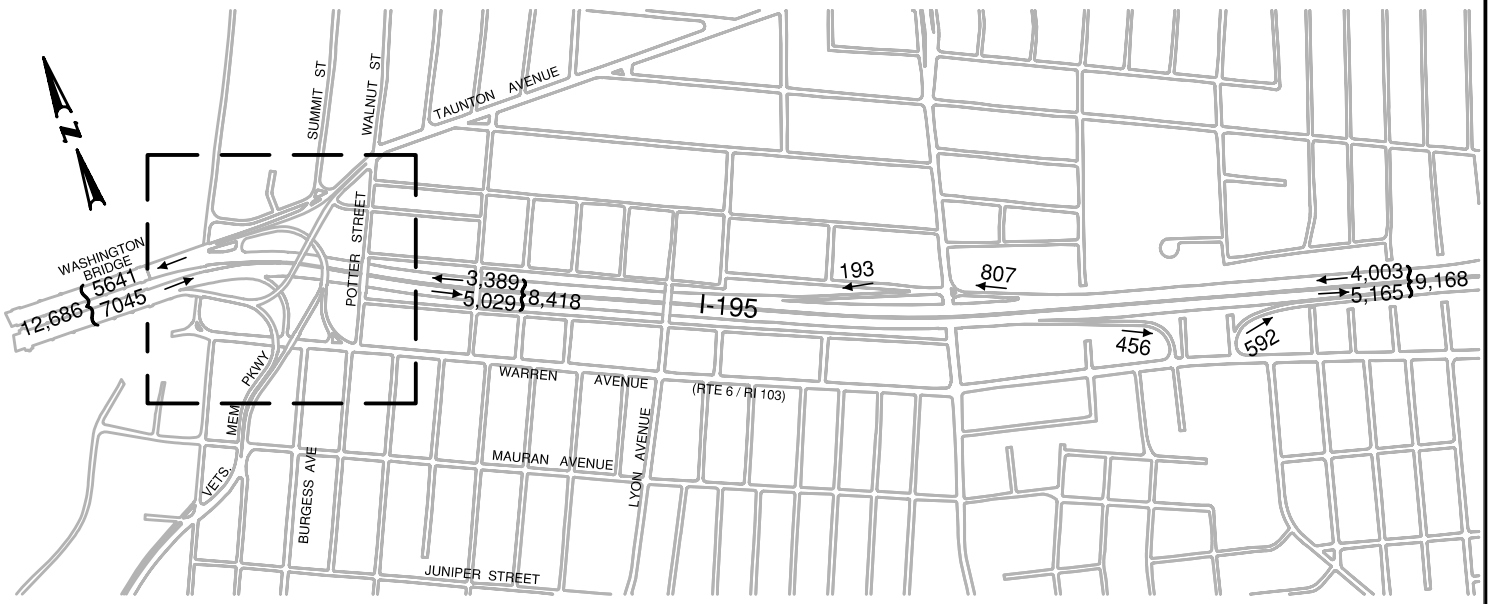
2.2 Accident Analysis

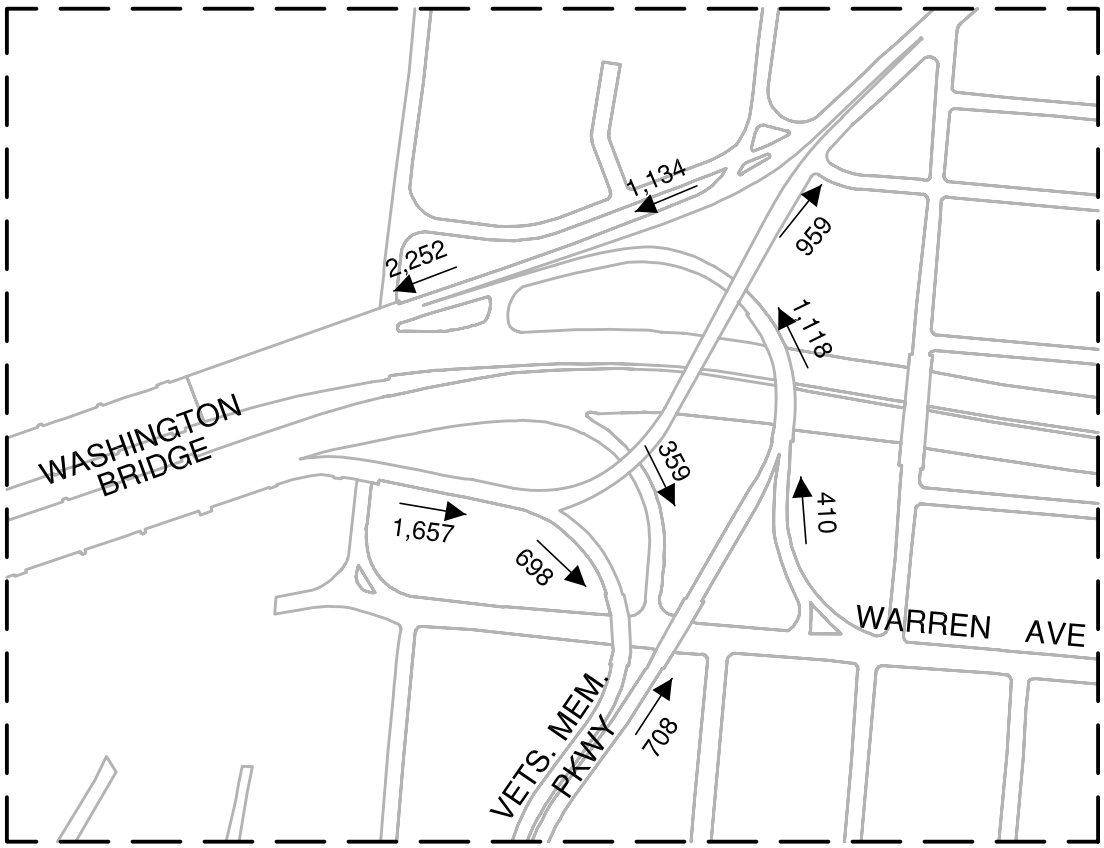
Accident data was collected from the Rhode Island Department of Transportation (RIDOT) and the City of East Providence Police Department for the project study area. The data covered a three-year period from 2001 to 2003. The data was categorized as intersection-related and roadway segment accidents. Intersection accidents included accidents that occurred within 200 feet of an intersection. Tables in Appendix B provide summaries of the accident data for each of the major roadways in the area. The accident data is summarized in terms of the number of accidents that resulted in property damage only (PDO) and the number of accidents that resulted in personal injury. In the three-year period, there were two fatalities reported in the project area. One involved a pedestrian crossing Interstate Route 195 in the vicinity of Exit 4. The other fatality occurred during a head-on collision on Veteran's Memorial Parkway near South Broadway.

Accident locations with five or more accidents in a twelve-month period were cited for further analysis. Accident rates were calculated for these locations. An accident rate represents the likelihood of an accident occurring at a given location in relation to the number of vehicles utilizing the roadway or intersection. Intersection accident rates are expressed as the number of accidents per million entering vehicles (MEV), and roadway segment accidents are expressed in terms of the number of accidents per 100 million vehicle miles (100 MVM) traveled.

The accident rates are shown in Table 1. Some states develop criteria for ranking accident locations. In the absence of state generated comparison rates, the industry standard has generally accepted that intersection accident rates greater than 1.5 accidents/MEV and roadway segment accident rates greater than 280 accidents/100 MVM are indicative of locations worthy of further study. This comparison has been applied to this study. As indicated in the table, five intersections and two roadway segments meet this criteria for further analysis.

The freeway accidents were plotted on mapping to identify clusters of accidents. On I-195 eastbound, clusters of accidents were revealed in the vicinity of Exits 4 and 5. In the westbound direction on I-195, cluster of accidents were identified in the vicinity of Exit 6. Many of these accidents occurred in the peak periods and involved rear-end collisions as motorists approached a back-up of freeway traffic on the highway.





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2004
PM PEAK HOUR
4:30 - 5:30
FREEWAY VOLUMES

FIGURE 8

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2004
PM PEAK HOUR
4:30 - 5:30
INTERSECTION VOLUMES

FIGURE 9

Table 1

ACCIDENT RATE SUMMARY

Major Road	Intersection	Average # Accidents/ Year	Entering Volume (ADT)	Accident Rate (A/MEV)
Lyon Avenue	@ Warren Avenue	7.7	12800	1.64
	@ Veteran's Memorial Parkway	5.7	22000	0.71
S. Broadway	@ Warren Avenue	27.7	26300	2.88
	@ Mauran Avenue	7.0	9900	1.94
	@ Freeborn Avenue	19.0	22600	2.30
	@ Veteran's Memorial Parkway	6.3	24800	0.70
Taunton Avenue	@ Summit Street	5.0	15400	0.89
	@ James Street	6.7	21000	0.87
	@ Purchase Street	5.3	23000	0.64
Vet. Mem. Pky	@ First Street	9.7	17900	1.48
Warren Avenue	@ Pawtucket Avenue	52.3	26300	5.45
	@ Brightridge Street	7.0	16200	1.18
	@ Slocum/Alford	6.0	20850	0.79

Roadway Segment	Roadway Segment Length (in feet) & Location	Average # Accidents/ Year	Entering Volume (ADT)	Accident Rate (A/100 MVM)
I-195	300 feet west of Exit 4 (EB)	11.3	81900	400
	Between Exit 4 and Potter St.(EB)	9.3	61600	231
	Between Potter & Broadway (EB)	8.0	58100	66
	Broadway to 195 On-Ramp (EB)	13.7	58100	284
	1000 feet east of Exit 6 (WB)	14.3	63200	328
	Exit 6 to 195 On-Ramp (WB)	32.0	55000	526
	195 On-Ramp to Purchase St. (WB)	10.3	58900	149
	Purchase St to VMP Overpass (WB)	9.3	58900	255

Collision diagrams were plotted for the major intersections with accident rates greater than 1.5 accidents/MEV. Collision diagrams illustrate a vehicle's path and collision type at the time of an accident. Collision diagrams are used to search for patterns and/or causes of accidents

at a particular location. Note that construction activities were occurring on I-195 as part of the Washington Bridge Project and the construction of the Taunton Avenue eastbound off-ramp during the three-year period for which accident data was reviewed. The construction activities may have contributed to the elevated occurrence of accidents on I-195.

Intersections with accident rates greater than 1.5 accidents/MEV are briefly discussed individually below.

Warren Avenue @ Lyon Avenue:

The intersection of Warren Avenue/Lyon Avenue is signalized. The accidents at this intersection consisted primarily of angle collisions and rear-end collisions. Rear-end collisions are common at a signalized intersection. However, signalization typically reduces the occurrence of angle-type collisions. Typically, angle-type collisions at a signalized intersection result from poor visibility of signals and/or inadequate signal timing. A field review at this location indicated that the signal heads are a mix of eight-inch and twelve-inch lenses and the signal heads are not LED. The signal operates on a 60-second cycle of which the side street is allotted approximately 17 seconds of green and yellow time. Potential improvements at this intersection include replacing the eight-inch signal heads with twelve-inch heads, providing LED lenses to improve visibility and revising the signal timing to allow longer green time for the side street traffic.

Broadway @ Freeborn Avenue and I-195 Ramps

There are two major accident types at this intersection. Approximately 40% of the accidents are rear-end collisions and 40% are sideswipes. On the northbound approach, Broadway has two lanes, one for left-turns and one for thru traffic. The southbound approach has two lanes including an exclusive right-turn lane and a thru lane. The westbound approach has a left-turn and a right-turn lane.

The accidents here tend to involve a thru vehicle maneuvering around a vehicle waiting to turn onto the I-195 ramp. It is important to note, however, that the lane arrangement at this intersection has recently been reconfigured through a re-striping under the bridge rehabilitation project for the I-195 Bridge over Broadway. The accident data reflect construction conditions. Further analysis is recommended at this location after the construction zone has been cleared and the intersection resumes its full capacity.

Broadway at Mauran Avenue

The intersection of Broadway at Mauran Avenue is unsignalized. Half of the accidents involved angle-type collisions. The other accidents involved varying collision types including side-swipe collisions, rear-end collisions, and collisions involving vehicles backing up. A field review indicated that there is poor sight distance from the Mauran Avenue eastbound approach. Looking to the north along Broadway, sight distance is restricted by a chain link fence and

sidewalk trees. To the south, a commercial sign and sidewalk trees hinder sight distance. Sight distance is better from the Laura Street westbound approach, however, motorists must pull up close to the travelway of Broadway to get a clear view.

Recommended improvements at this location include relocating the commercial sign that blocks sight distance and replacing sidewalk trees with trees that are less massive.

Broadway at Warren Avenue

Broadway at Warren Avenue is a high capacity signalized intersection. Approximately 35-percent of the accidents plotted for this location involved rear-end collisions. Thirty-four percent involved angle-type collisions and 12-percent involved side-swipe collisions. Based on a field review of the intersection, there are numerous curb cuts along both Broadway and Warren Avenue that fall in close proximity of the intersection. These curb cuts increase the conflict points. Some of the rear-end collisions may occur when a motorist is turning into a driveway and the motorist behind them anticipates that the motorist is turning at the intersection. There is good signal visibility. The southbound approach has an advanced green phase. The eastbound approach declines at a grade of approximately three-percent, which may account for the rear-end collisions on this approach during inclement weather.

Improvements to this intersection are proposed under the Build Alternatives and the Upgrade/TSM Alternative. The proposed improvements involve increasing the capacity through the signalized intersection by allowing two through lanes on Warren Avenue. The types of improvements necessary to improve safety at this intersection involve limiting the number of curb cuts in close proximity to the intersection, limiting the curb cuts to right in/right out only, or implementing turn restrictions perhaps by installing median islands on the intersection approaches.

Warren Avenue at Pawtucket Avenue

The signalized intersection of Warren Avenue/Pawtucket Avenue services a high volume of traffic. Approximately 32-percent of the accidents at this intersection are rear-end collisions which is common at signalized intersection. Angle type collisions account for 37-percent of the accidents. Typically, signalization reduces angle-type collisions since the conflicting movements are permitted on separate signal phases. Side-swipe collisions account for 18-percent of the accidents.

There is good signal visibility at this intersection and each approach has an exclusive left-turn lane. Both roadways have commercial driveways in close proximity to the intersection. The accident reports indicate that a number of the accidents assigned to this intersection deal with vehicular movements into and out of the surrounding commercial driveways.

To reduce accidents at this intersection, the City of East Providence should consider

reducing the number of curb cuts near the intersection, limiting the commercial driveways in close proximity to the intersection to right in/right out movements, or implementing turn restrictions by installing median islands on the intersection approaches.

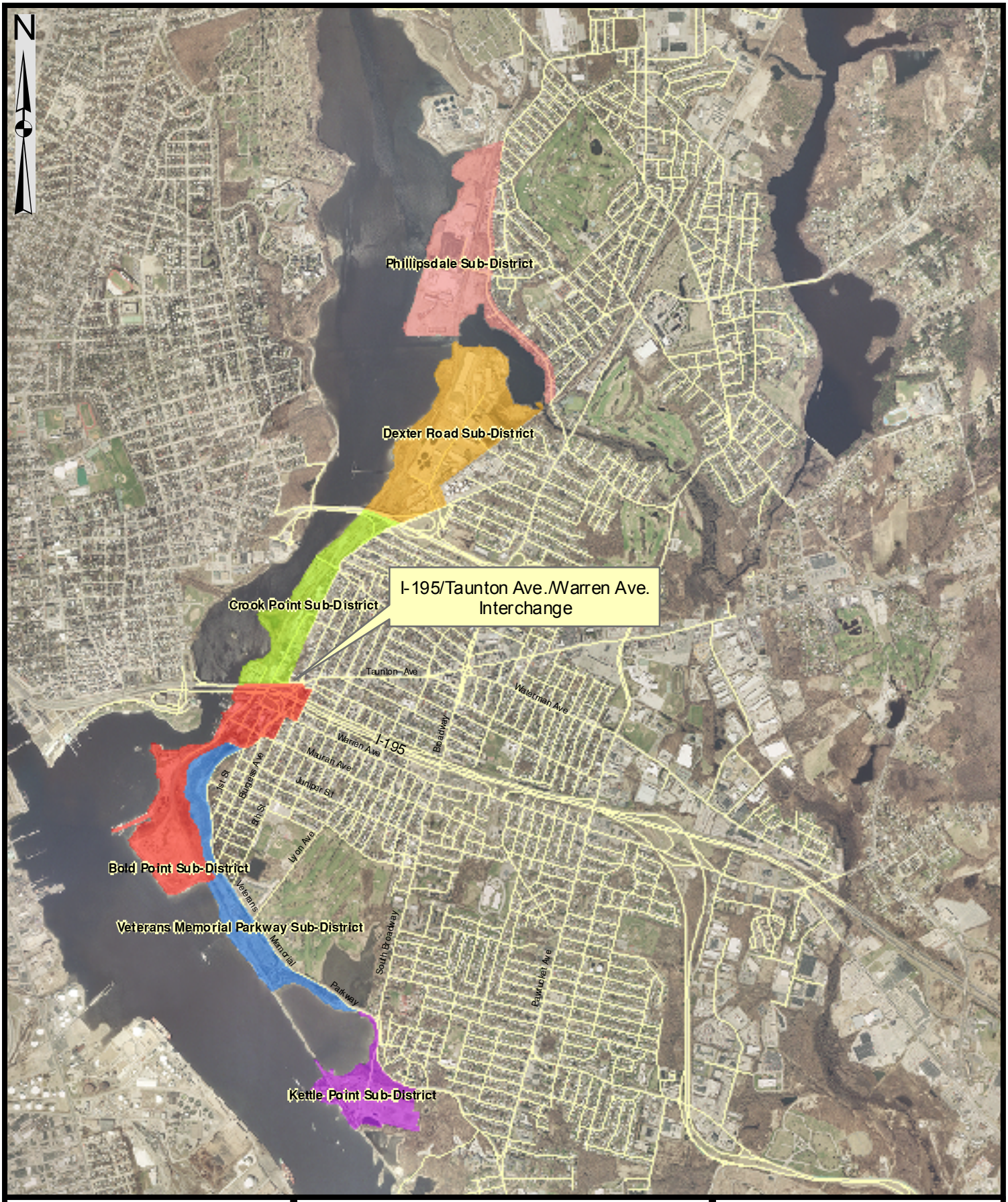
3.0 PROJECTED TRAFFIC VOLUMES

3.1 Projected Land Use

The project study area is expected to experience the usual background growth of traffic as a result of typical growth of an area or region over time. In some cases, a particular development or area of development results in growth that is over and above the typical trends. Relative to traffic growth, these types of developments are often referred to as special generators. In the project study area, the anticipated development of the Waterfront Special Development District in East Providence is significant and cannot be viewed as part of the background growth. As such, the Waterfront District has been given special attention relative to this project.

In 2003, the City of East Providence adopted the "East Providence Waterfront Special Development District Plan," commonly referred to as the "Waterfront District Plan." The plan presents the vision and strategy to transform underutilized waterfront along the Seekonk and Providence Rivers to a mix of land uses. The over 300 acres of waterfront area is expected to be developed as a mix of commercial, office, residential, restaurants, marinas and recreational uses. See Figure 10 for the Waterfront District.

The project's urban planners reviewed the Waterfront District Plan and developed case studies in which nine mixed-use developments were compared to the Waterfront District. The Waterfront District consists of six sub-districts, five of which fall within the area of influence for the I-195/Taunton Avenue/Warren Avenue Interchange Improvement Project. For this study, the projected land use was estimated for five sub-districts. The projected land use was identified by type, size and density. The projections represent reasonable estimates of the amount of development that is likely to occur by 2030, the project's design year. Table 2 summarizes the projected Waterfront Development within the project study area.



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Interchange

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WATERFRONT
SPECIAL DEVELOPMENT
DISTRICT PLAN

0 500 1,000 2,000 3,000 4,000 Feet

FIGURE 10

Table 2

Potential Development of Waterfront District within Study Limits

Subdistrict	Acres	Proposed Land Use	Housing Units	Commercial GSF
Bold Point Harbor				
Colfax Properties	10	50% High-Density Residential	148	
		50% Office		64,500
Union Oil (Pier Road)	9	100% Commercial (Retail/Restaurant)		135,000
Providence & Worcester RR	47	25% High-Density Residential	325	
		75% Commercial (Office & Retail)		1,600,000
Wilkes Barre Pier	2	100% Commercial (Retail, Rest., hotel, marina)		46,000
Warren Rd & First St Prop.	5	100% Commercial (Retail, Restaurnat, Hotel)		140,000
Boston Street	1	100% Commercial (Retail, Office)		15,000
Pier Road Properties	6	100% Commercial (Retail, Restaurant)		87,000
Water Street Properties	4	100% Commercial (Retail, Rest., Hotel, Marina)		57,000
Veterans Memorial Pkwy				
Chevron Properties	24	85% High-Density Residential	750	
		15% Commercial (Retail, Restaurant, Marina)		78,000
Kettle Point Area				
B.P. Amoco	19	95% Medium-Density Residential	165	
		5% Commercial (Retail, Marina)		20,300
Atlantic Richfield	19	95% Medium-Density Residential	165	
		5% Commercial (Retail)		20,700
Crook Point Area				
Crook Point	8	95% High-DensityResidential	210	
		5%Commercial (Marina)		8,500
1 Waterman Ave - Red Br.	7	85% High-Density Residential	120	
		15% Commercial (Retail, Rest., Office, Hotel)		22,000
100 Water Street	5	100% Commercial (Retail, Rest., Hotel, Marina)		140,000
Providence & Worcester RR	7	100% Commercial (Retail, Restaurant)		102,350
Dexter Rd/Pawtucket Ave				
Assorted Lots	113	100% Commercial (Office, Lt. indust., Lt. manuf., Research & Development)		1,147,000

3.2 Special Traffic Generators

After estimating the type and density of development that is expected to occur by 2030, the corresponding number of trips projected for the waterfront sub-districts were developed. The trip generation rates as published by the Institute of Transportation Engineers (ITE) in the *Trip Generation Manual* were applied to the land use projections. Since each waterfront sub-district is expected to include mixed-use development, it is likely that some of the trips to and from the sub-district will be dual-purpose trips. For example, an office worker in a sub-district may also choose to shop or frequent a restaurant in the same sub-district as his place of employment. As indicated in Transportation and Land Development published by ITE, studies have shown that the total trip generation of a mixed-use site was approximately 20-percent less than that of the same land uses developed as stand-alone establishments. To account for shared trips within the Waterfront, a 20 percent shared-trip rate within sub-districts was applied.

Trip generation estimates are summarized in Table 3. Trip generation is presented for each of the five sub-districts. In total, the five Waterfront sub-districts are expected to generate approximately 61,200 trips per day, with 4100 trips in the morning peak hour and 6300 trips expected in the afternoon peak hour.

The residential development in the Waterfront area is expected to be high-density and medium-density residential units. The units may be apartment units and/or condominium units, depending on the housing market. After reviewing the trip generation rates for a variety of high-density residential units, the trip generation rates for a residential condominium were applied as it represented a fairly average estimate.

The description of anticipated development at the Dexter Road/Pawtucket Avenue area sub-district fit that of a business park in ITE's Trip Generation Manual. As such, the trip generation rates for a business park were applied for this location.

While seven marinas were identified in the initial Potential Development Assessment as potential development, two primary marinas are likely to emerge in the Waterfront area. The other marina locations are likely to consist of small boat tie-ups. Based upon the advice of the urban planners, marinas were included at Crook Point and the Veterans Memorial Parkway sub-district.

The trip generation estimates for the Waterfront Development were utilized in the traffic modeling efforts.

Table 3

Trip Generation for the Waterfront District

Land Use Code	Land Use Type	Unit of Measurement	Size	Total Weekday Trips	AM Peak Hour Total	PM Peak Hour Total
Trip Generation for Bold Point Harbor						
230	Residential (condominium)	unit	473	2439	175	222
710	Office	1000 GSF	1036.5	7996	1202	1241
820	Retail/Restaurant	1000 GSF	576.75	21032	454	1996
760	Research & Development	1000 GSF	320	2665	376	350
310	Hotel	Rooms	325	2539	177	156
420	Marina	Berths	Negligible			
		Subtotal:		36672	2384	3965
Trip Generation for Veterans Memorial Parkway						
230	Residential (condominium)	unit	750	3609	252	325
820	Retail/Restaurant	1000 GSF	58	4802	115	438
420	Marina	Berths	200	789	16	38
		Subtotal:		9200	383	801
Trip Generation for Kettle Point Area						
230	Residential (condominium)	unit	330	1796	132	165
820	Retail/Restaurant	1000 GSF	31	3210	79	290
420	Marina	Berths	100	600	8	19
		Subtotal:		5606	219	474
Trip Generation for Crook Point Area						
230	Residential (condominium)	unit	330	1796	132	165
710	Office	1000 GSF	13.2	280	37	94
820	Retail/Restaurant	1000 GSF	129.65	8055	187	745
310	Hotel	Rooms	200	1810	249	237
420	Marina	Berths	Negligible			
		Subtotal:		11941	605	1241
Trip Generation for Dexter Road/Pawtucket Avenue Area						
770	Business Park (office/lt. indust./lt. man.)	1000 GSF	1147	13073	1585	1378
		Subtotal:		13073	1585	1378
Grand Totals:						
Total Trips:				76491	5175	7859
Shared Trips:				15298	1035	1572
New Trips:				**61193**	**4140**	**6287**

3.3 Traffic Model

The Rhode Island statewide travel demand forecasting model was used to aid in the analysis of traffic volume changes resulting from improvements to the I-195/Taunton Avenue/Warren Avenue interchange. The Rhode Island statewide model was developed by the Rhode Island Statewide Planning Program with funding from the Rhode Island Department of Transportation. This model was originally developed over 30 years ago. The model has had two major updates, the first occurring from 1990-1994 when the model was moved to a micro-computer environment. The second update was completed in 2005. This second update focused on updates to the population and employment inputs and the modeling software.

The intent of the statewide model is to provide an environment to simulate the activities of the transportation system. This simulation can be used to test the impacts of proposed transportation system changes or land use changes. One of the major applications of the statewide model is to input forecasted population and employment and to test the existing transportation infrastructure to determine the locations of areas needing improvement.

The statewide planning model is designed to be a state-of-the-practice model and is similar in design and use to statewide planning models in Massachusetts, Connecticut, New Hampshire, and Vermont. These models are known as "aggregate planning models." This means that the models do not simulate the activities of individual businesses or households. Instead, communities are sub-divided into traffic analysis zones, and each zone represents a sub-area of the community having similar land use and travel patterns. The activities of the zone are then simulated as a single unit of activity. "Disaggregate planning models" are designed to simulate individual household and business activity. Disaggregate models provide significantly more capability for evaluating local road and intersection activity, but they are significantly more expensive to build and maintain. There are only a handful of disaggregate planning models in existence, and none of these cover an entire state.

The geographic range of the Rhode Island statewide model is the entire State of Rhode Island, as well as border communities in Massachusetts and Connecticut. The Rhode Island model has sub-divided the state into 904 traffic analysis zones. Portions of the model covering Massachusetts and Connecticut account another 388 zones, making the total number of traffic analysis zones 1292. The principal land use inputs to the Rhode Island statewide model are: population, households, autos available, retail employment, and non-retail employment. The model is designed around a base year of 2000 (corresponding to the 2000 US Census), and forecast years of 2003, 2005, 2007, 2010, 2015, 2020, 2025, and 2030. The model is designed to predict traffic volumes consisting of directional link flows, as well as intersection turning movements. The model can predict these conditions for the average weekday AM peak hour, PM peak hour, and daily.

The Rhode Island statewide model transportation network includes all roads in the State which are functionally classified by the Federal Highway Administration as collector streets or

higher. Within Rhode Island, the model covers over 2,400 miles of road. The total roadway miles within and outside the State covered by the model is over 3,700.

For the I-195/Taunton Avenue/Warren Avenue interchange study, the model was used to test how changes in the roadway system and interchange impact area traffic volume and congestion. Based on an initial review of the statewide model, it was determined that the model required some refinement before it could be used for the interchange study. This refinement came in two general areas. The first refinement was to sub-divide the traffic analysis zones in and around the interchange. The second refinement was to add more roads into the model in the sub-divided area.

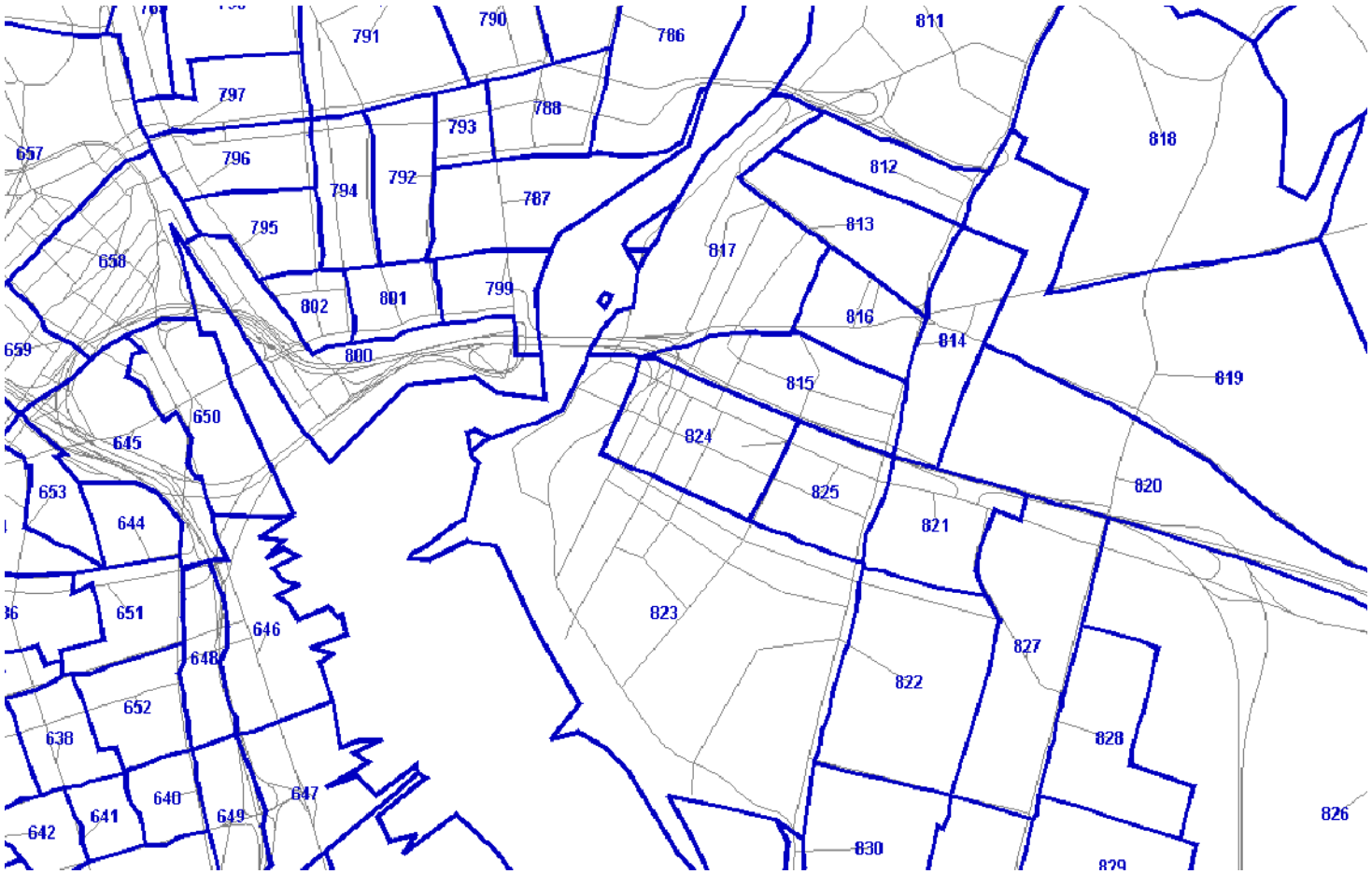
In and around the area of the I-195/Taunton Avenue/Warren Avenue interchange, the traffic analysis zones were very large and in need of sub-dividing in order for the model to accurately predict intersection turning movements and ramp volumes. In and around the interchange there were 6 traffic analysis zones covering this section of East Providence (East Providence is actually sub-divided into 47 zones). These 6 zones were sub-divided into 16 traffic zones. The following table below shows the original zone ID number and the results of the sub-division.

Table 4

Zone Splitting

Original Zone ID	New Zone IDs
811	811, 1266
815	815, 1261
817	817, 1262
823	823, 1258, 1259, 1264, 1265
824	824, 1260
823	832, 1263

Figure 11 shows the area of East Providence around the I-195/Taunton Avenue/Warren Avenue interchange. In this figure, the modeled roadway network is shown in black. The original traffic zone boundaries and the zone identification numbers are shown in blue. As can be seen the area of interest is along the river and adjacent to the interchange. After completing the sub-dividing process, the land use projections for this area included in the model were updated.



LEGEND

TRAFFIC ZONE BOUNDARY

CAMBRIDGE SYSTEMATICS INC. Cambridge, MA	Improvements to the I-195/Taunton Avenue/Warren Avenue Interchange East Providence, Rhode Island	TRAFFIC ZONE BOUNDARIES FIGURE 11

As a further adjustment to the modeling process, additional road network was needed to support the sub-divided zone system. Following the completion of the zone splitting and network enhancements, the model was re-calibrated in the interchange area. This recalibration process used 46 traffic counts available in the waterfront area of East Providence. Model calibration is achieved by making small adjustments to roadway speed and capacity.

Following the completion of the calibration, the model was ready to test variations in the interchange configuration and how these variations impacted traffic flow and intersection turning movement volumes. There were three network scenarios tested. The first was a "No-Build," or do nothing, alternative. This is basically the base network condition against which the build conditions are tested. This base condition was run for the 2030 forecast year. General descriptions of the two build alternatives are as follows:

Build Scenario 1: Waterfront Drive 1 & 2 improvement consists of following network changes:

1. Existing Valley St. connecting from Warren Ave. to Taunton Ave is removed.
2. Improve capacity at the roundabout at Mauran Ave – 2 lanes
3. Add proposed EB 1 lane I-195 on-ramp from Warren Ave
4. Add proposed WB 1 lane I-195 off-ramp to Waterfront Drive
5. Improve capacity at Veterans Memorial Parkway near the roundabout.
6. Extend Taunton Ave to connect to Waterfront Drive extension.

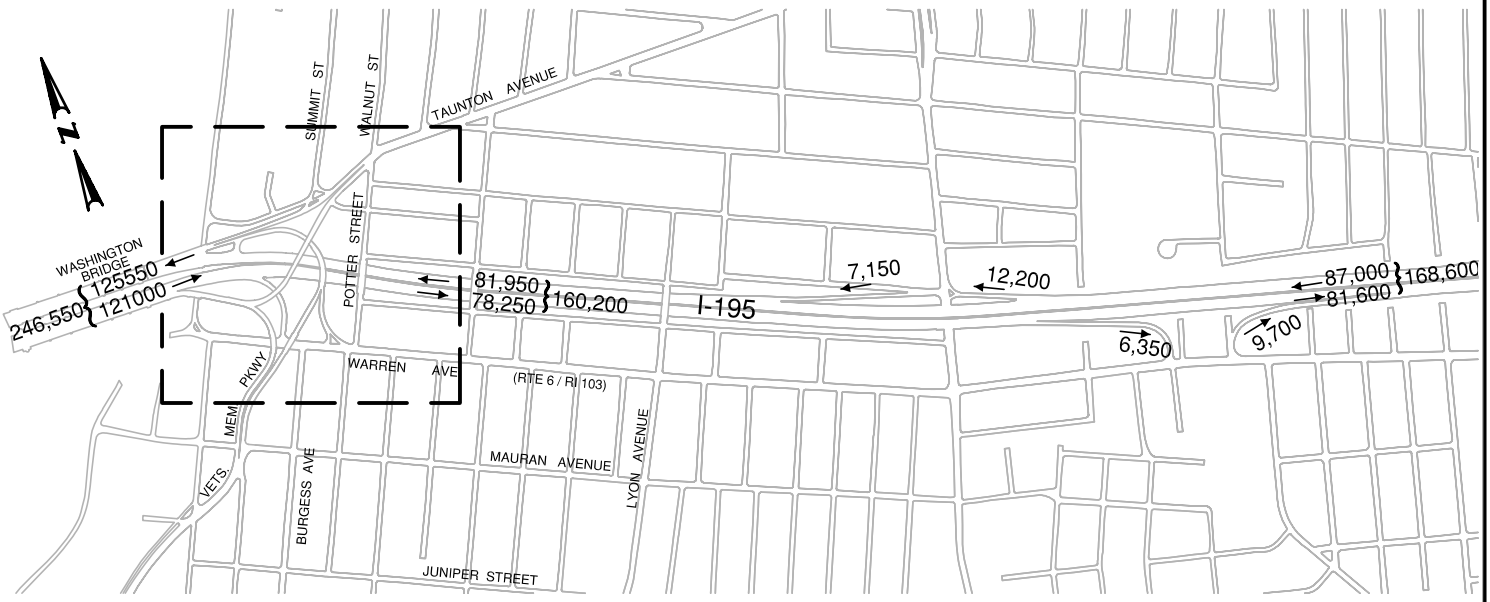
Build Scenario 2: Veterans Memorial Parkway improvement consists of following network changes:

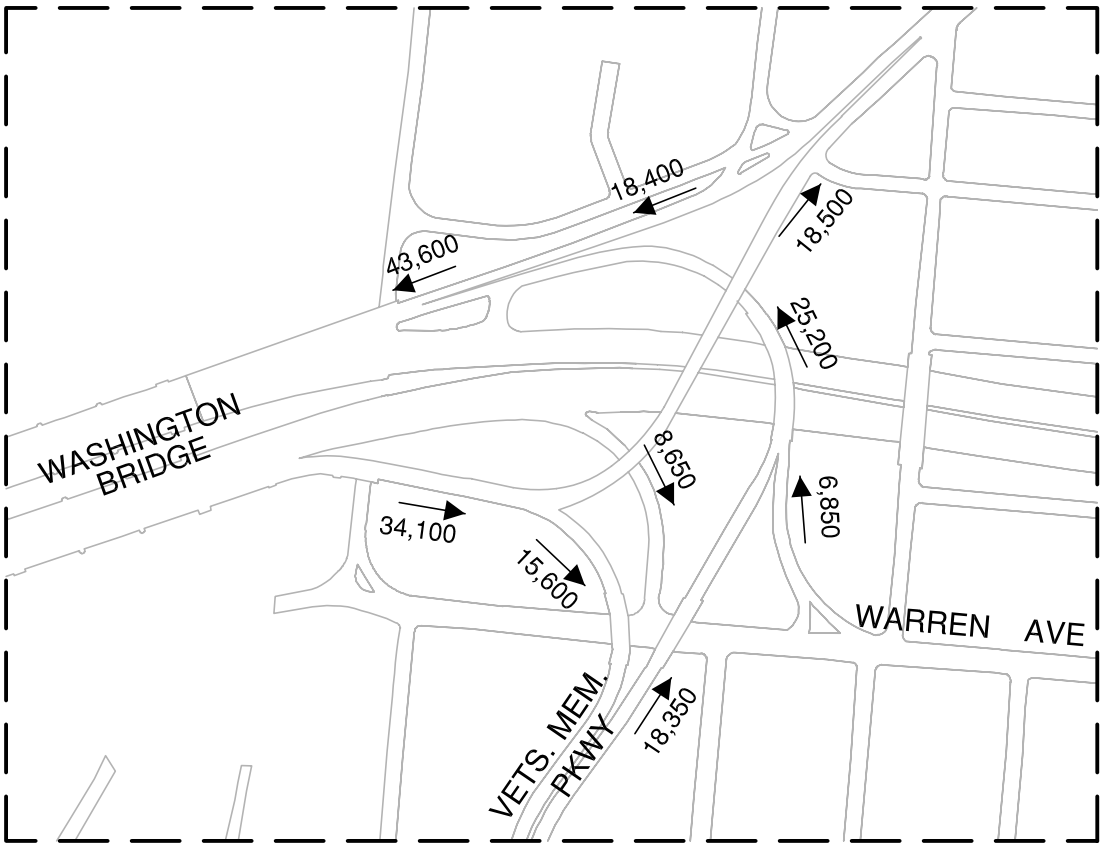
1. Add a 1 lane new ramp from Veterans Memorial Parkway to I-195 EB
2. Improve capacity at the roundabout at Mauran Ave – 2 lane
3. Improve capacity at Veterans Memorial Parkway near the roundabout.
4. Add 1 lane New WB off-ramp from I-195 to Taunton Ave
5. Add 1 lane New ramp from I-195 WB to Veterans Memorial Parkway
6. Delete Potter St. over I-195.
7. Delete on-ramp from Warren Ave to I-195 WB
8. Extend Taunton Ave. from Valley St. to Waterfront Drive extension

3.4 Projected Traffic Volumes

Through the traffic modeling efforts described above, future year traffic projections were developed for the project. 2030 was selected as the design year to represent a five-year build-out and a 20-year serviceable life span for the improvements. Traffic projections were developed for the no-build alternative and the build alternatives.

Figure 12 shows the projected 2030 No-Build AADT for freeway volumes, and Figure 13 shows the intersection volumes. The projected 2030 No-Build traffic volumes were compared to the 2004 existing traffic volumes. The freeway volumes are expected to increase by 37-44





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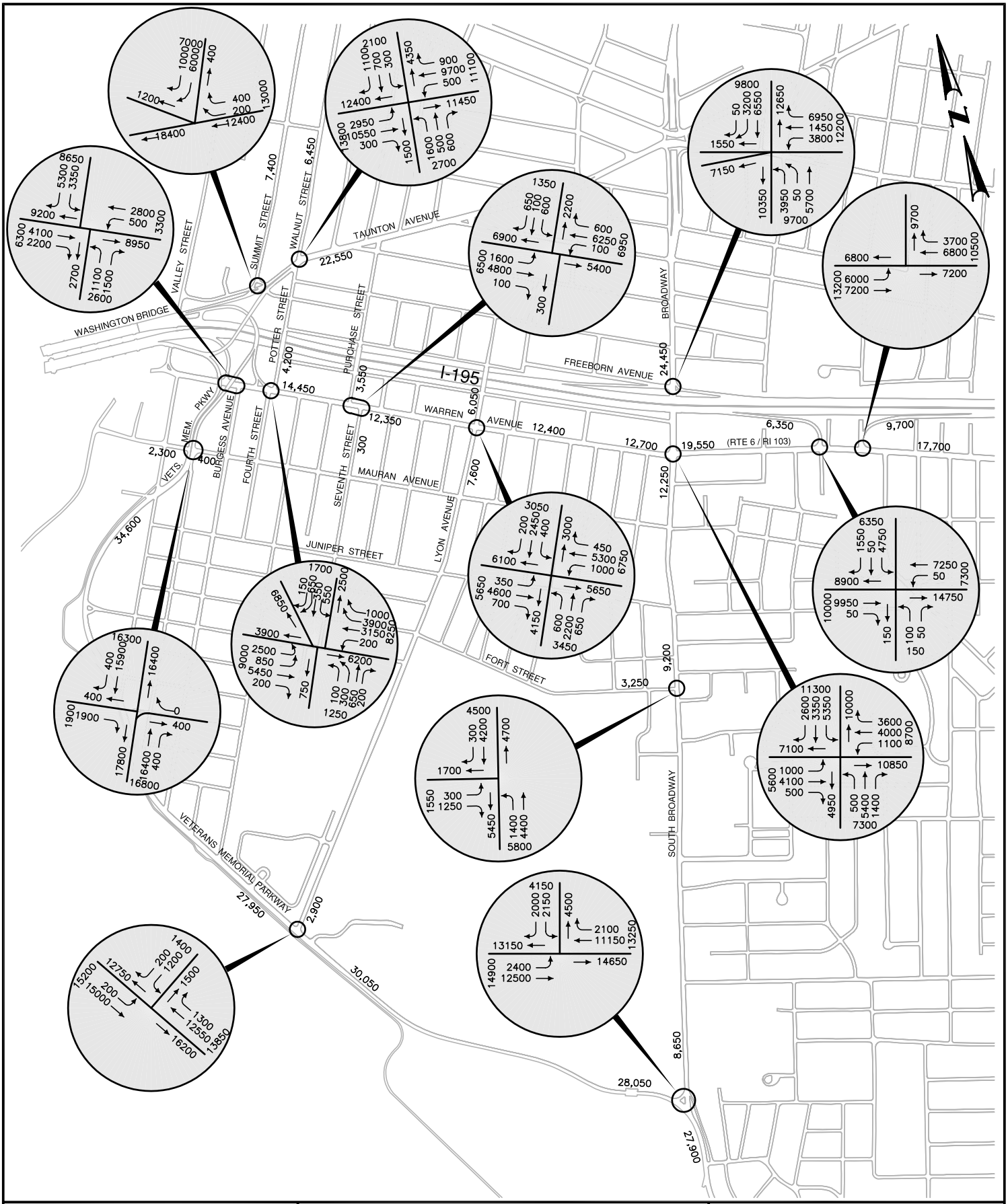
Improvements to the
I-195/Taunton Avenue/Warren Avenue
Interchange
East Providence, Rhode Island

2030 NO BUILD
AVERAGE ANNUAL
DAILY TRAFFIC
(AADT)
FREEWAY VOLUMES

FIGURE 12



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Improvements to the
I-195/Taunton Avenue/Warren Avenue
Interchange
East Providence, Rhode Island

2030 NO BUILD AVERAGE ANNUAL DAILY TRAFFIC (AADT)

INTERSECTION VOLUMES

FIGURE 13

percent, which represents a growth rate of approximately 1.4% per year. The AM and PM peak hour projected traffic volumes for the No-Build conditions are shown in Figures 14-17.

Traffic was assigned to the build alternatives by applying the street network changes described previously to the traffic model. Traffic assignments for Waterfront Drive 1 and 2 are the same and shown in Figures 18-23. The newly proposed ramps are expected to carry a total of 8400 vehicle-trips per day (vpd), with 6150 vpd on the I-195 EB on-ramp and 2250 vpd on the I-195 WB off-ramp. Under this assignment, the volume on the ramps to and from the east at the adjacent I-195/Warren Avenue/Broadway Interchange (Exit 6) will be reduced by 20 percent.

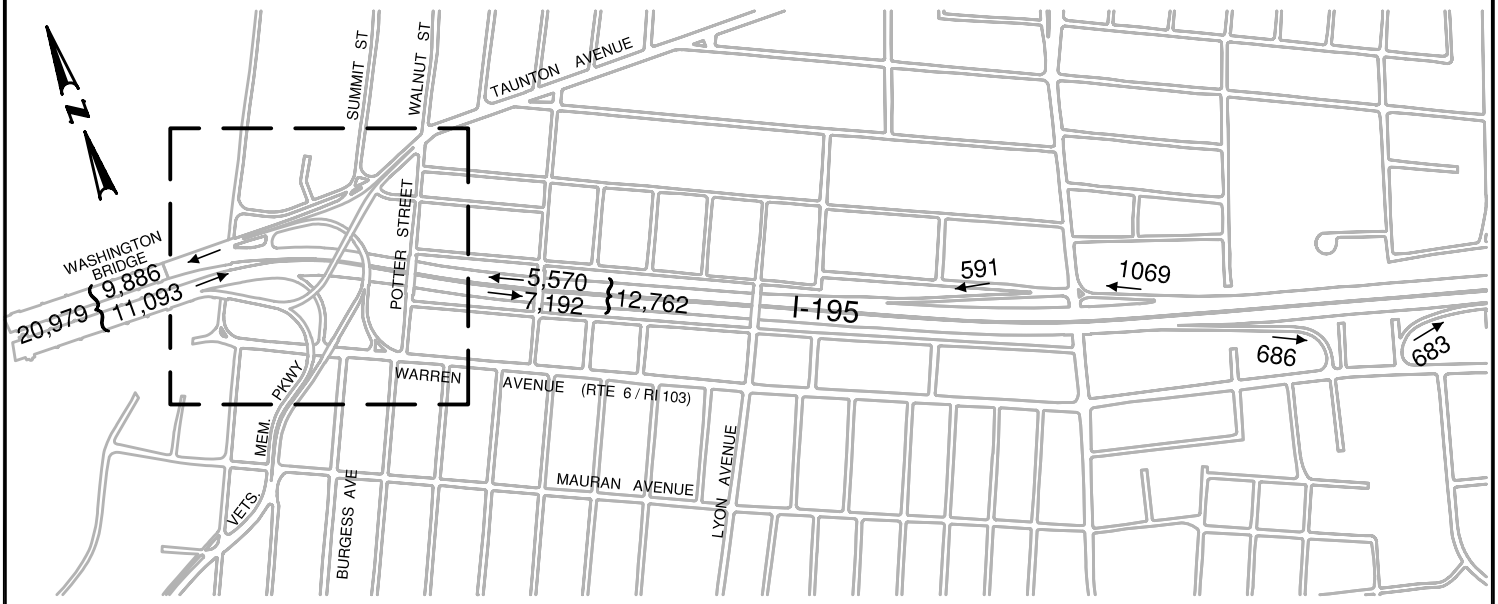
Traffic assignments for Veterans Memorial Parkway are shown in Figures 24-29. The newly proposed ramps in this alternative are expected to carry 6450 vpd in the year 2030, with 3600 on the I-195 EB on-ramp and 2850 vpd on the I-195 WB off-ramp. Note that the 2850 vpd on the proposed I-195 WB off-ramp includes 1400 vpd assigned to the ramp onto Taunton Avenue. The ramp onto Taunton Avenue is considered controversial since it allows traffic to enter an already congested area without providing any relief or improvement to that area. The assignment for the Veterans Memorial Parkway alternative will also reduce the volume on the existing ramps based to and from the east at the I-195/Warren Avenue/Broadway interchange by approximately 20 percent. Refer to Table 5 for a comparison of traffic assignments.

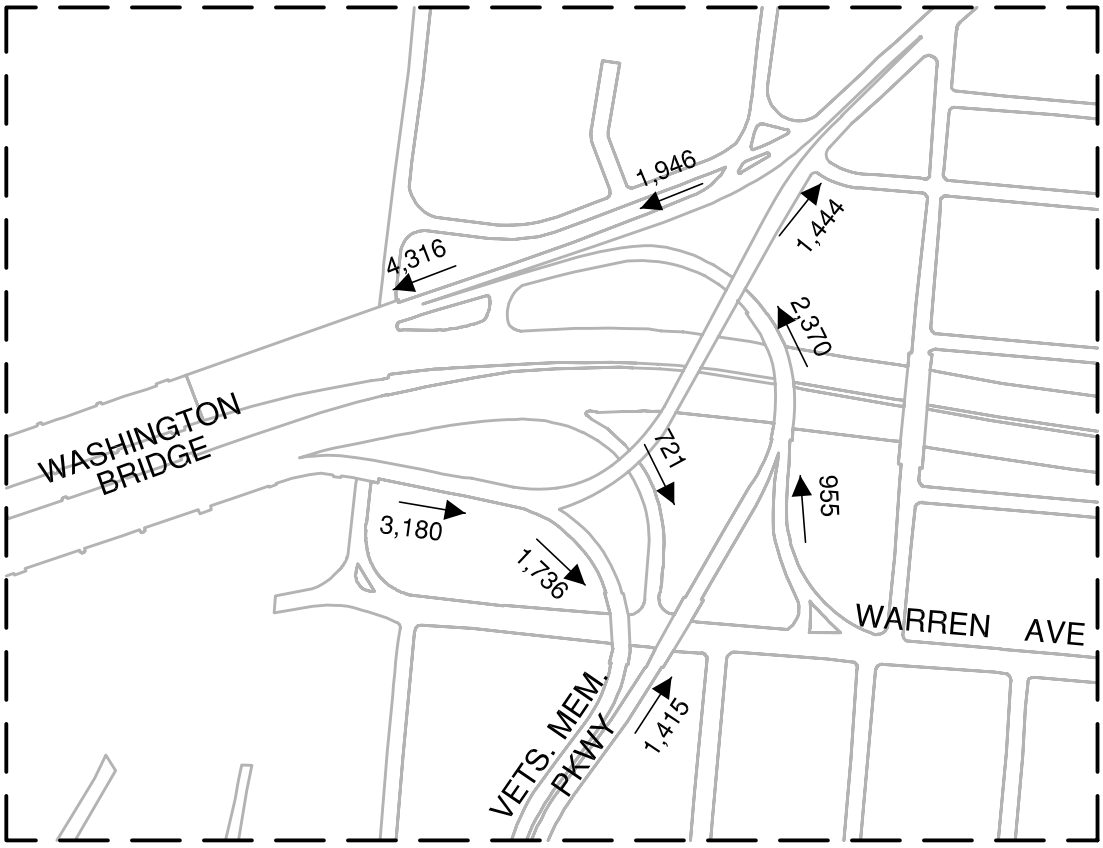
The build assignments are compared in terms of the relief provided to Warren Avenue, which is the current route to and from I-195 based to the east. Veterans Memorial Parkway reduces traffic along Warren Avenue by an average of 3000 vpd. The Waterfront Drive alternatives reduce the Warren Avenue traffic by an average of 1700 vpd. While the Waterfront Drive alternatives do relieve traffic on Warren Avenue, they also attract an element of traffic to Warren Avenue to access the new eastbound on-ramp.

3.5 Capacity Analysis

Capacity analyses were conducted for key intersections and the freeway components within the project study area. Initially, the base year 2004 conditions were analyzed based upon the existing roadway conditions. Then the future year 2030 traffic volumes were analyzed based upon the existing roadway conditions along with any known roadway projects that will be completed by 2030. These analyses serve as a basis for comparison. Lastly, the traffic assignments for the build alternatives were analyzed in terms of capacity analyses and compared to the results of the 2030 No-Build Condition.

The capacity analyses were conducted using the procedures contained in the 2000 Highway Capacity Manual (HCM). The adequacy of traffic operations on any given section of roadway or at a particular intersection is expressed in terms of its "level of service." The concept of level of service is a qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers. A level-of-service definition





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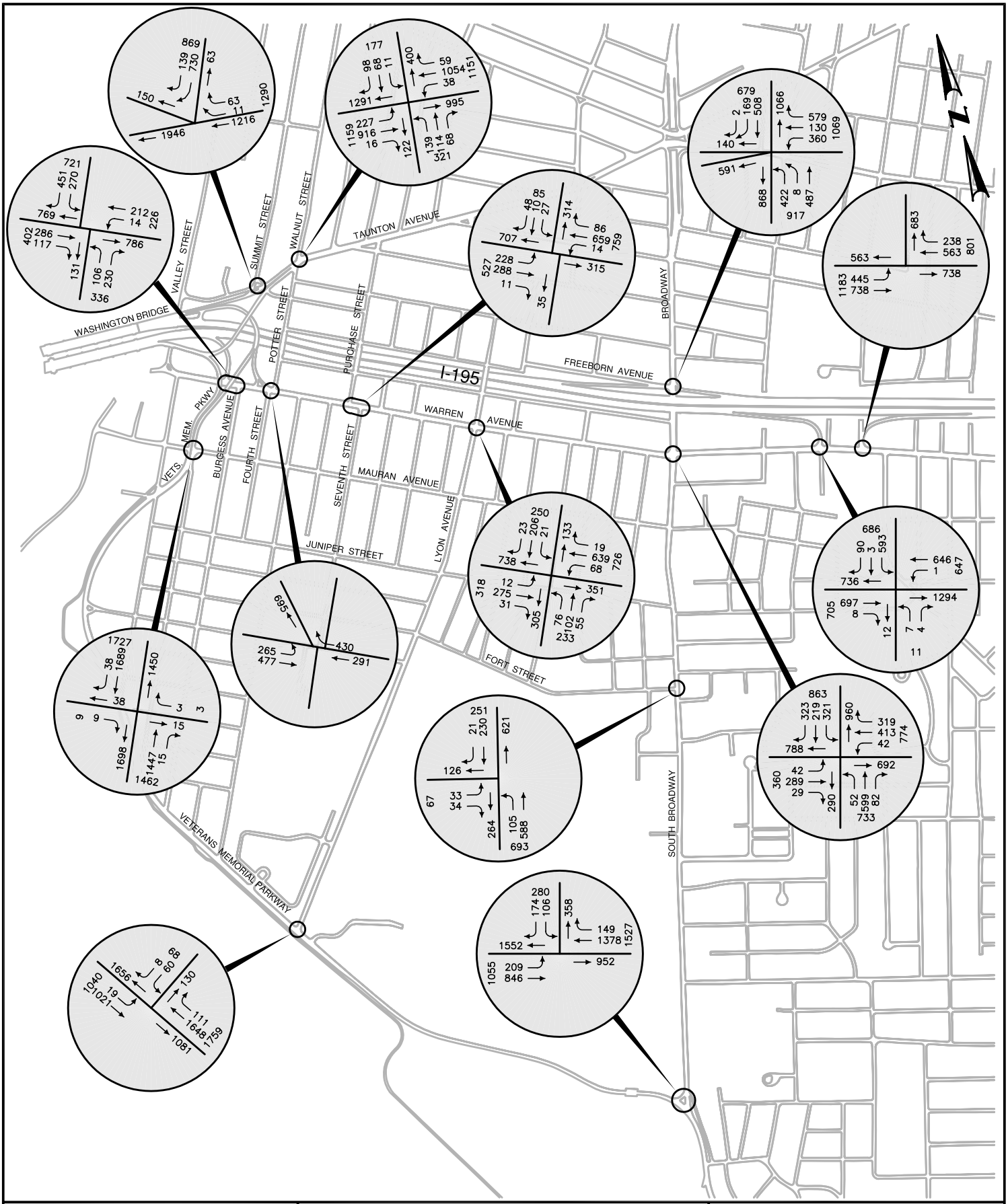
Improvements to the
I-195/Taunton Avenue/Warren Avenue
Interchange
East Providence, Rhode Island

2030 NO BUILD
AM PEAK HOUR

FREEWAY VOLUMES

FIGURE 14



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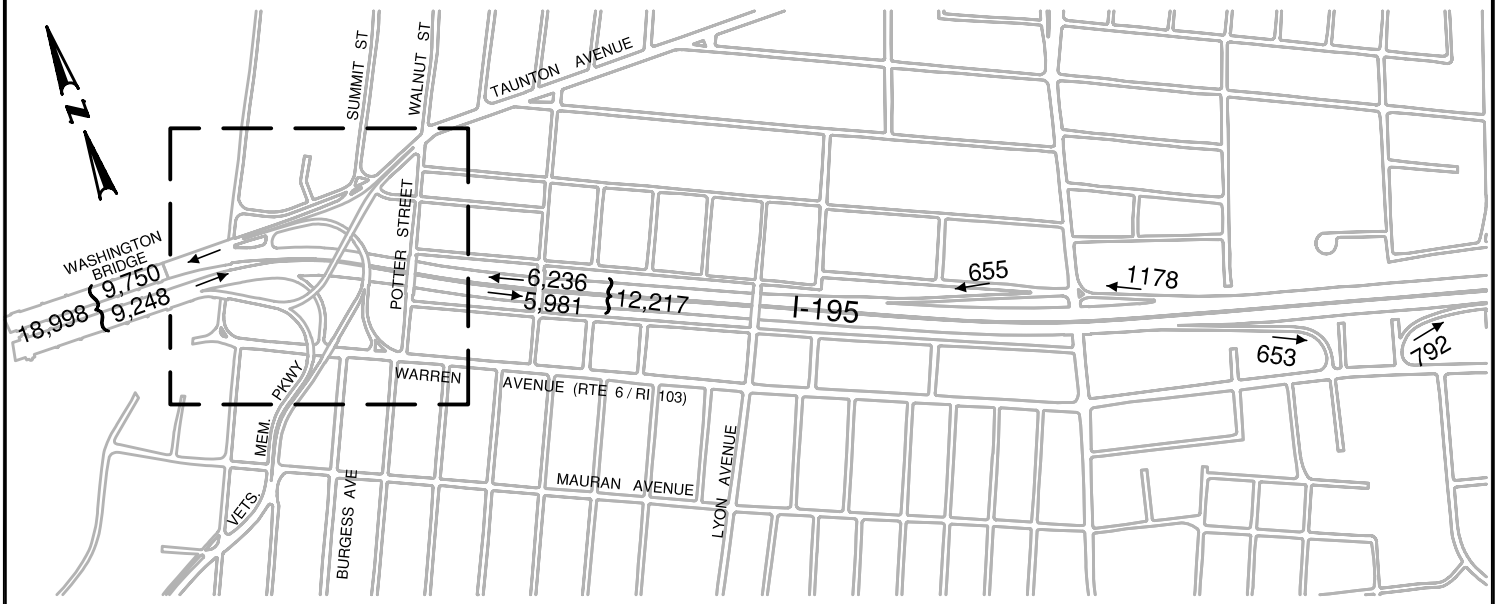
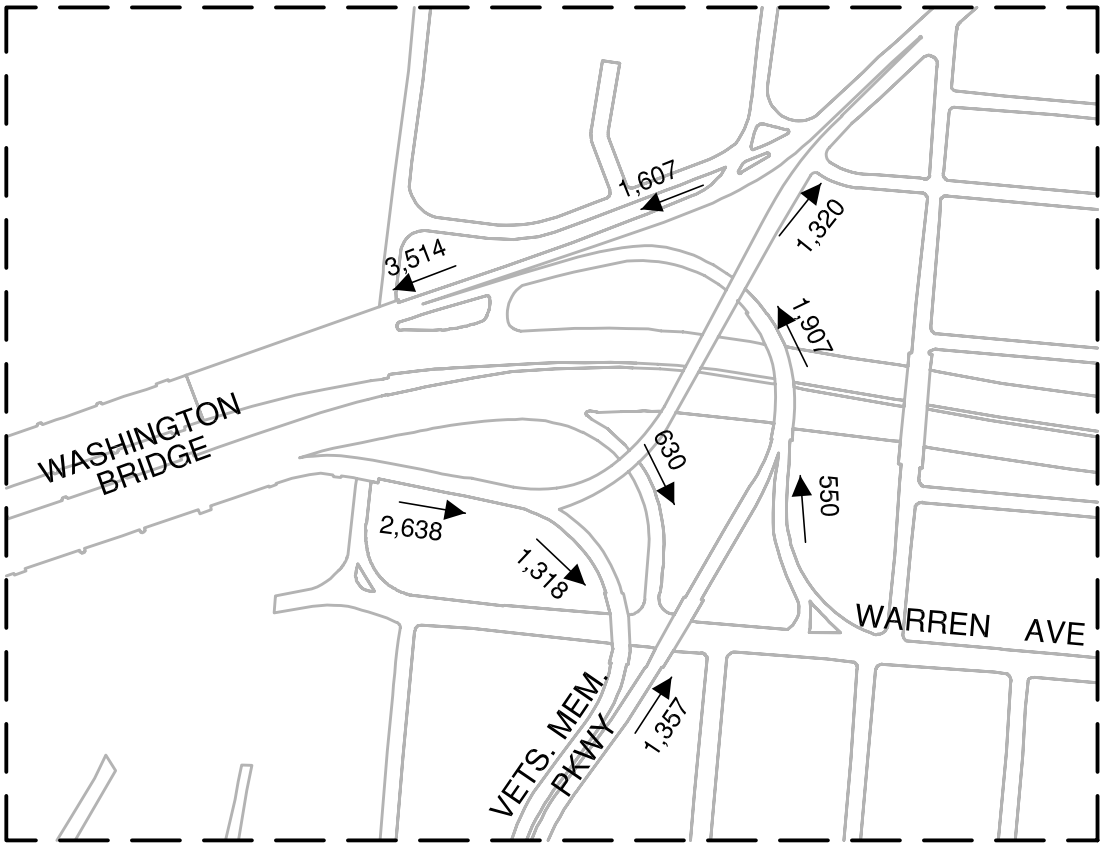
Improvements to the
I-195/Taunton Avenue/Warren Avenue
Interchange
East Providence, Rhode Island

2030 NO BUILD
AM PEAK HOUR

INTERSECTION VOLUMES

FIGURE 15





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Improvements to the
I-195/Taunton Avenue/Warren Avenue
Interchange
East Providence, Rhode Island

2030 NO BUILD
PM PEAK HOUR

FREEWAY VOLUMES

FIGURE 16

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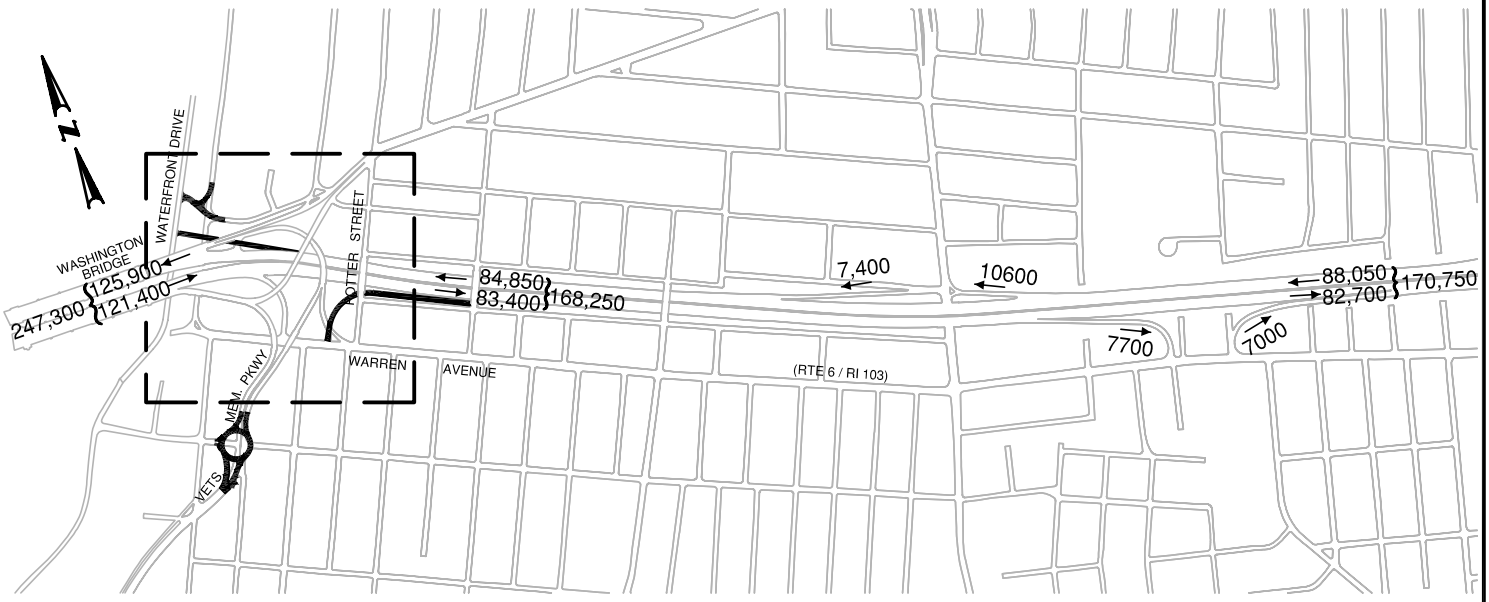
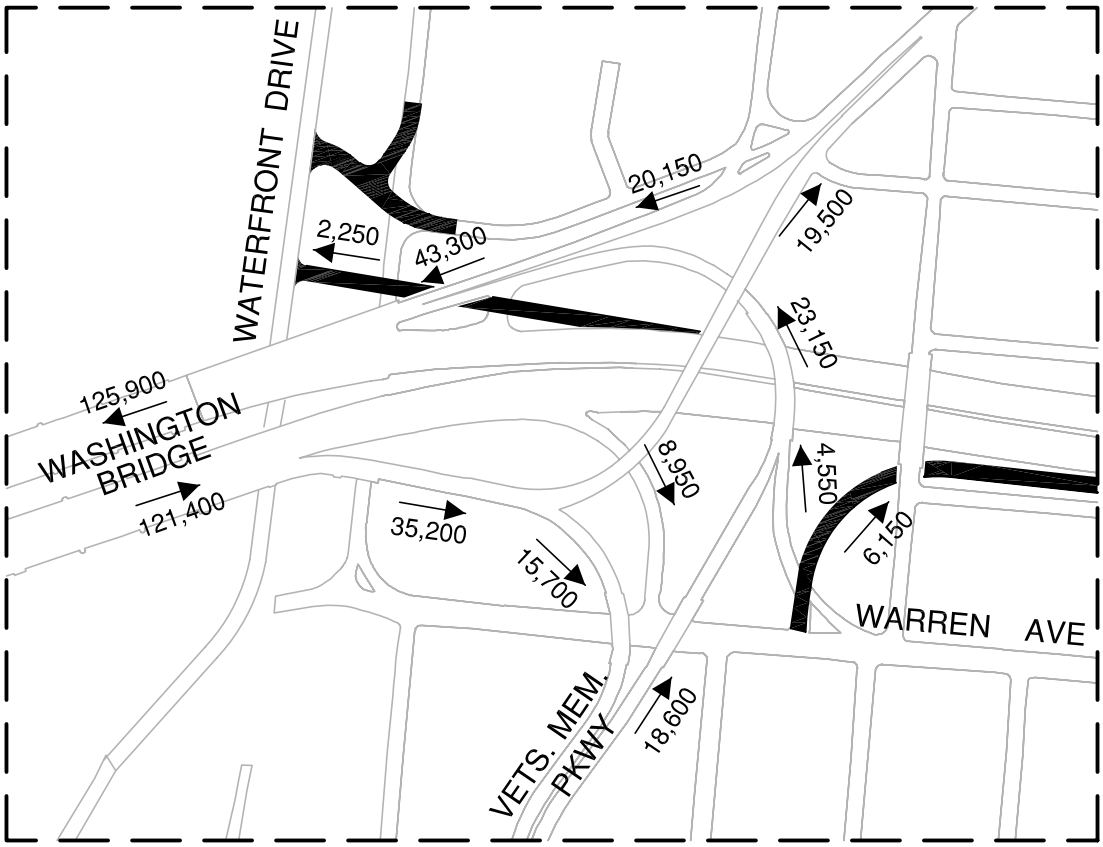
Improvements to the
I-195/Taunton Avenue/Warren Avenue
Interchange
East Providence, Rhode Island

2030 NO BUILD
PM PEAK HOUR

INTERSECTION VOLUMES

FIGURE 17





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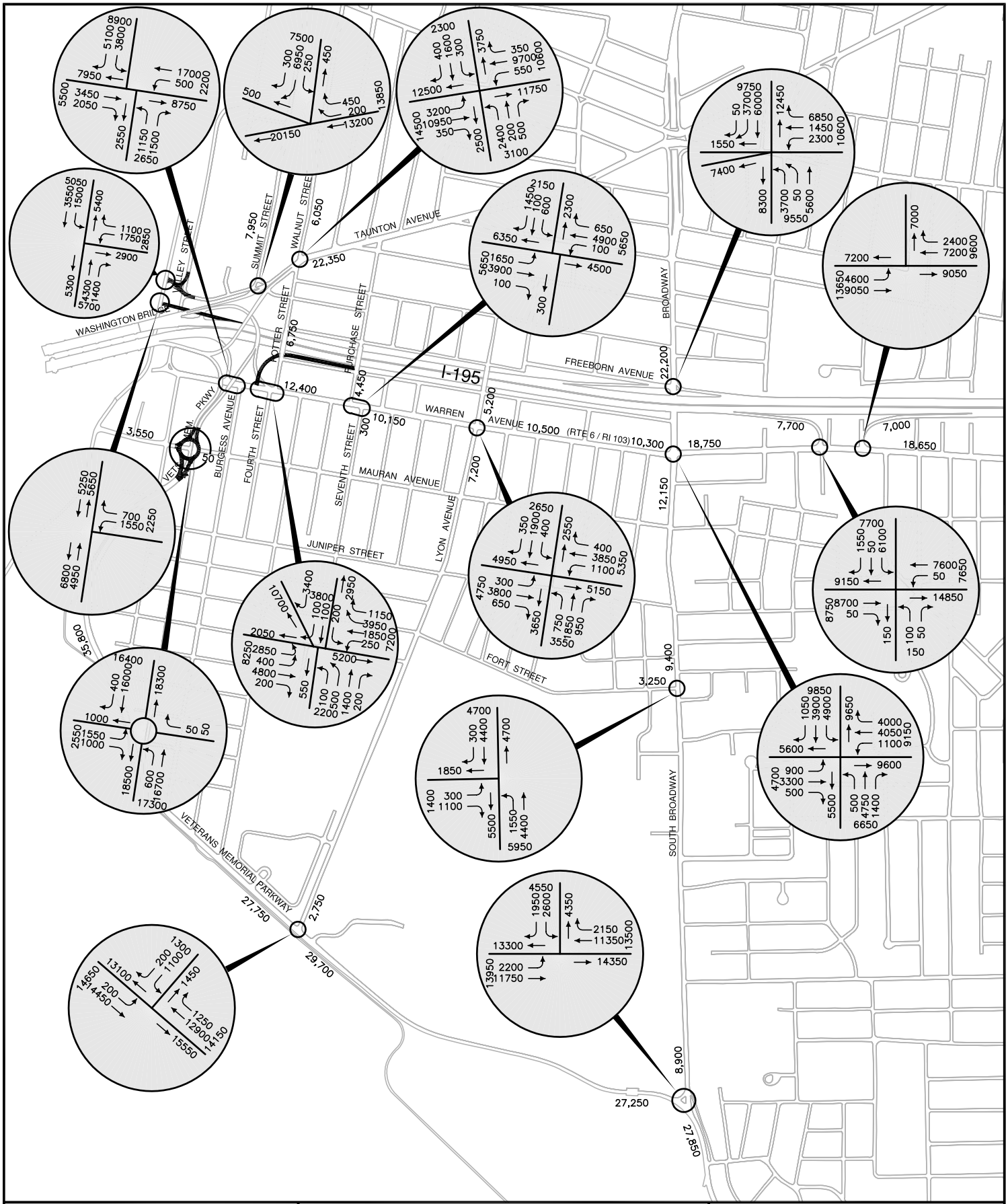
Improvements to the
I-195/Taunton Avenue/Warren Avenue
Interchange
East Providence, Rhode Island

2030 BUILD
WATERFRONT DRIVE 1 & 2
AADT
FREEWAY VOLUMES

FIGURE 18



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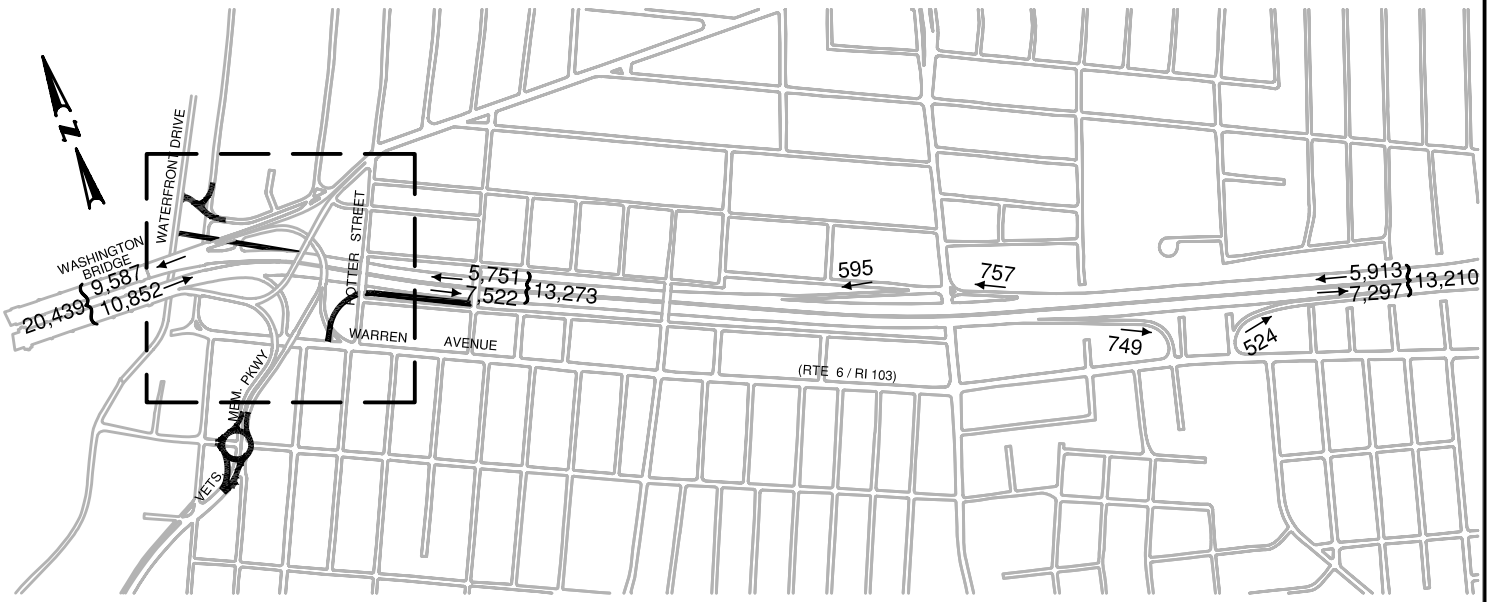
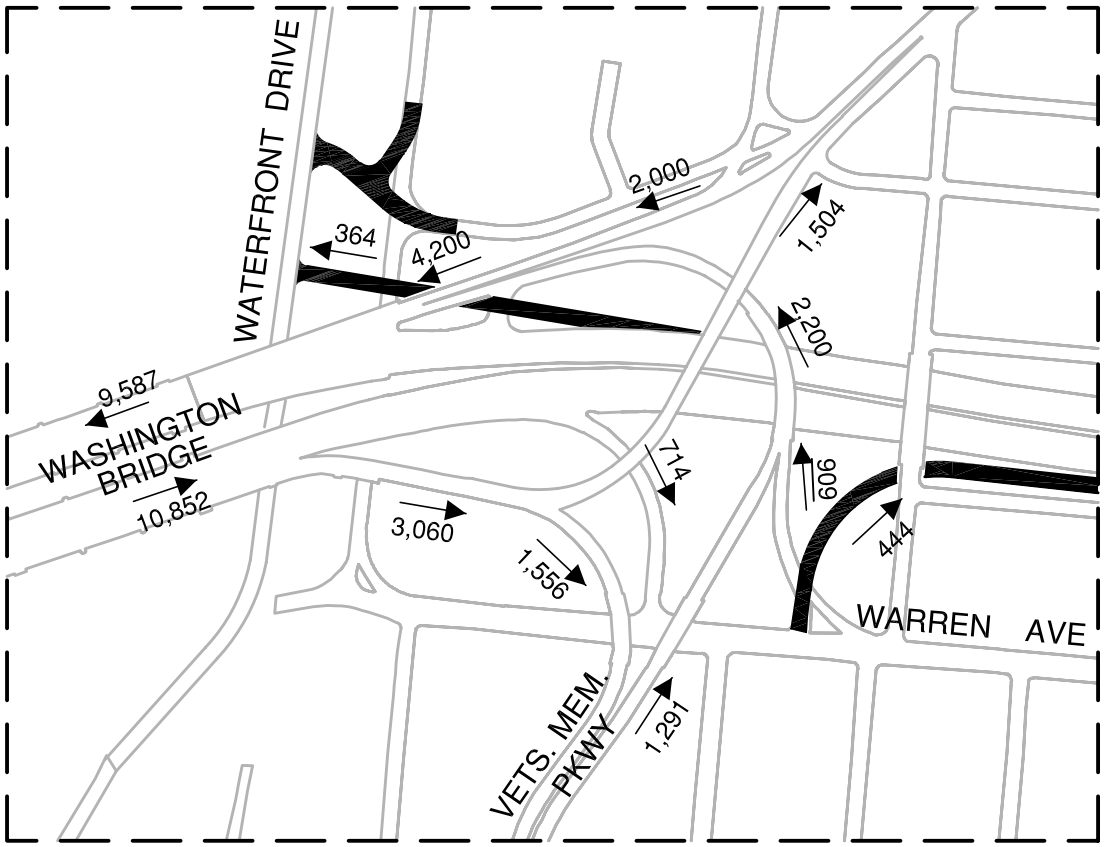
Improvements to the
I-195/Taunton Avenue/Warren Avenue
Interchange
East Providence, Rhode Island

2030 BUILD
WATERFRONT DRIVE 1 & 2
AADT
INTERSECTION VOLUMES

FIGURE 19





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Improvements to the
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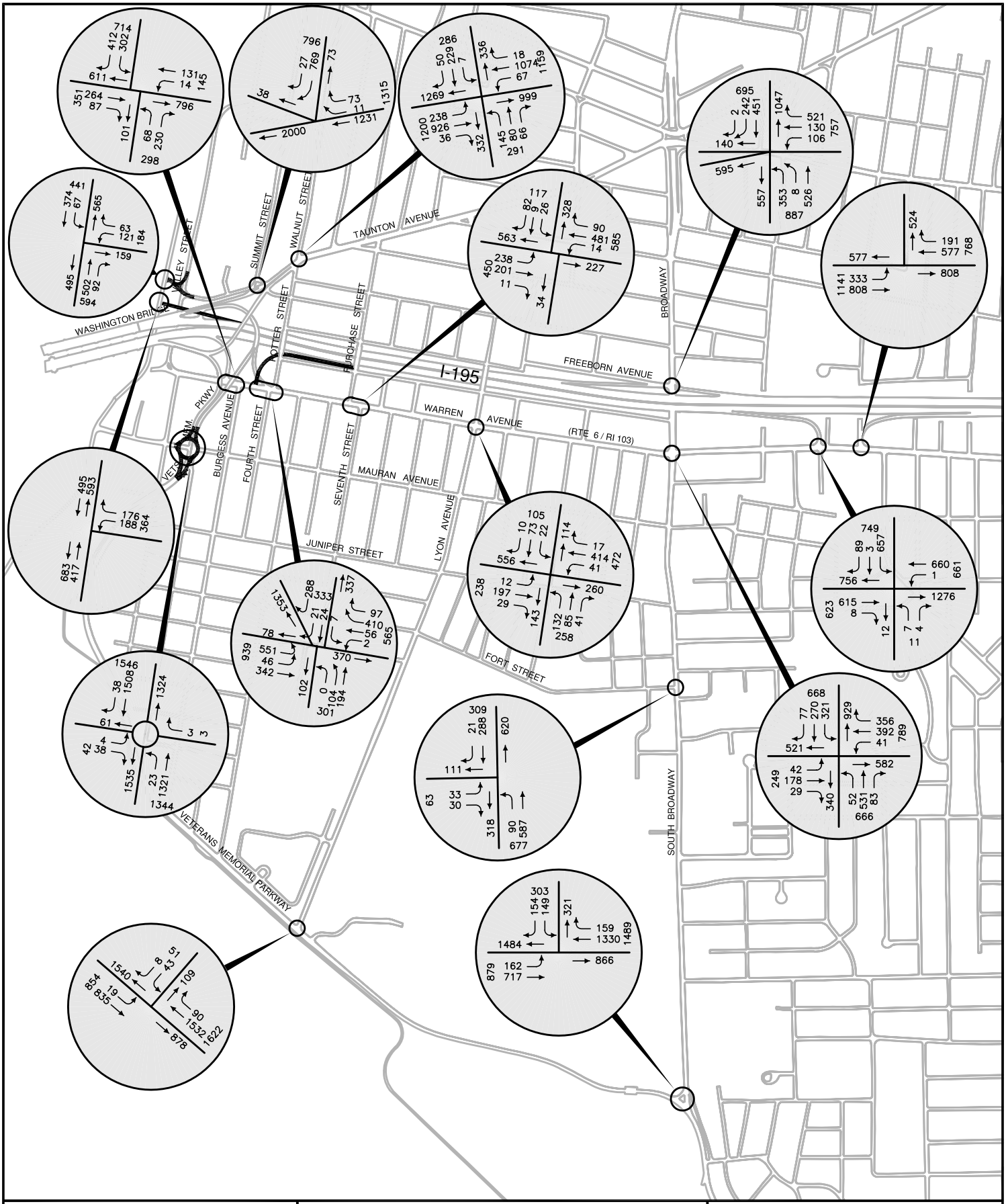
Interchange
East Providence, Rhode Island

2030 BUILD
WATERFRONT DRIVE 1 & 2
AM PEAK HOUR
7:30 - 8:30
FREEWAY VOLUMES

FIGURE 20



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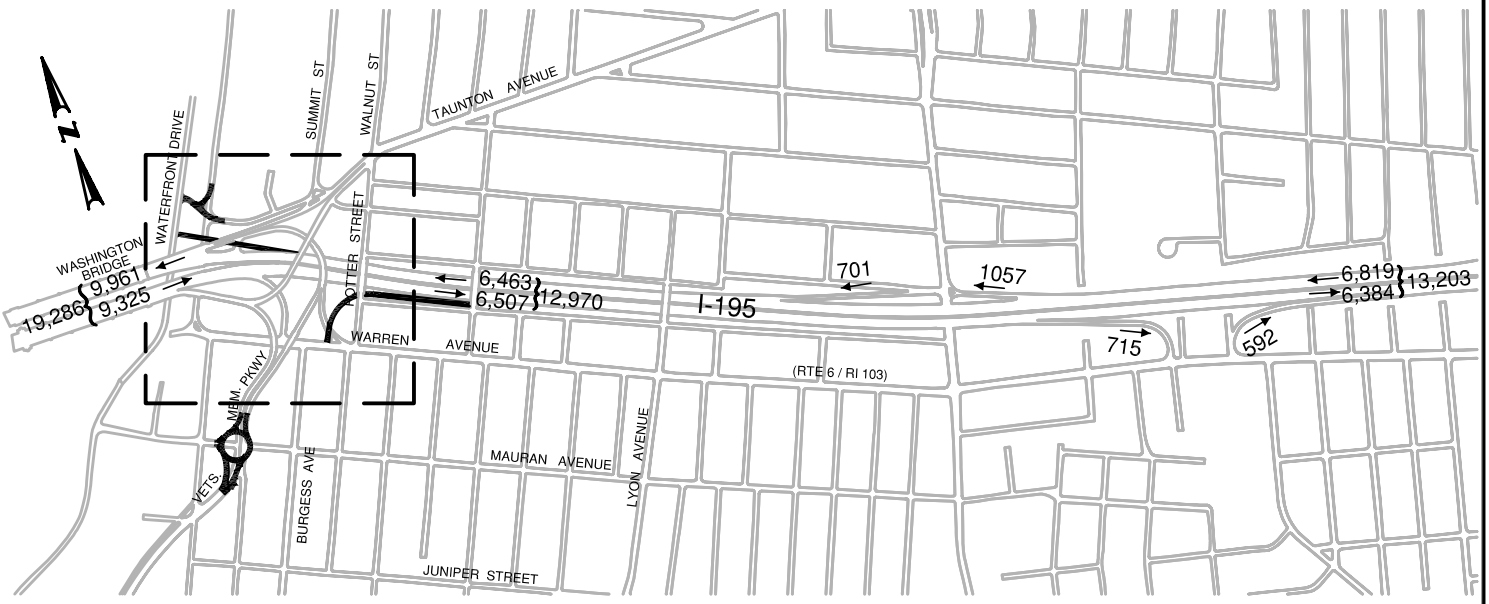
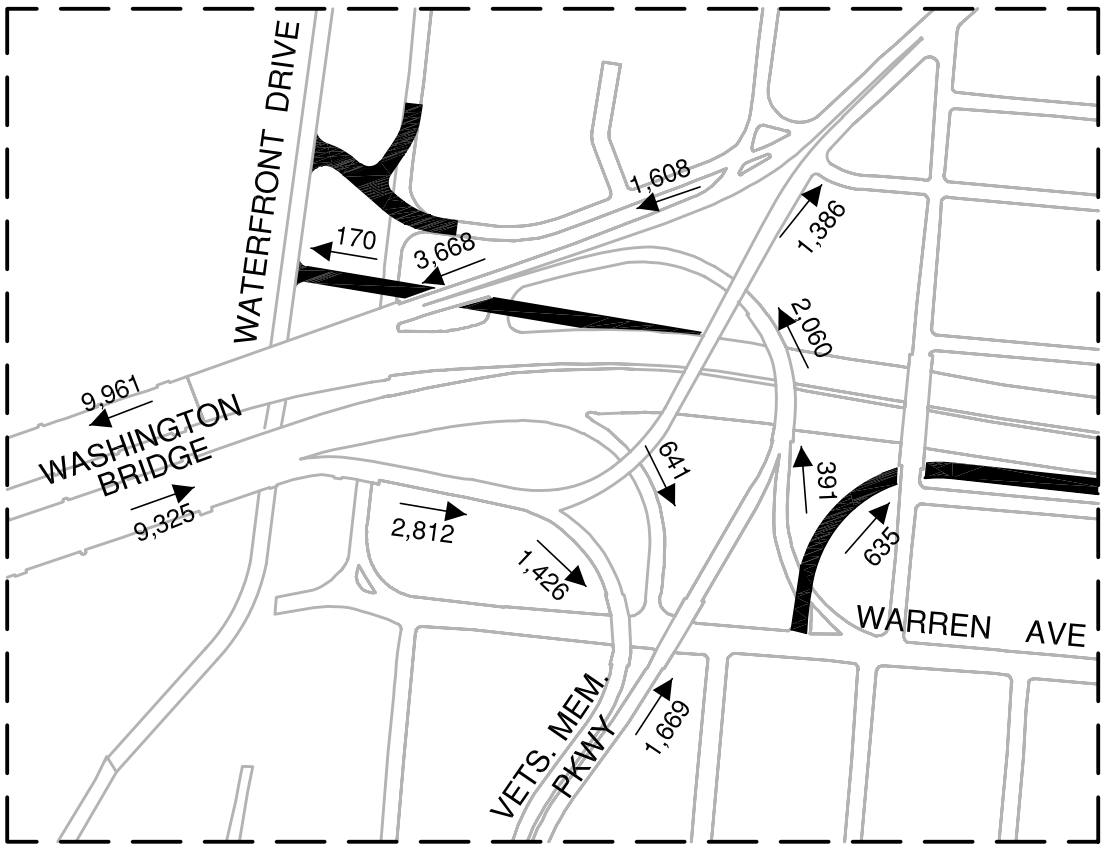
Interchange
East Providence, Rhode Island

2030 BUILD
WATERFRONT DRIVE 1 & 2
AM PEAK HOUR
7:30 - 8:30
INTERSECTION VOLUMES

FIGURE 21





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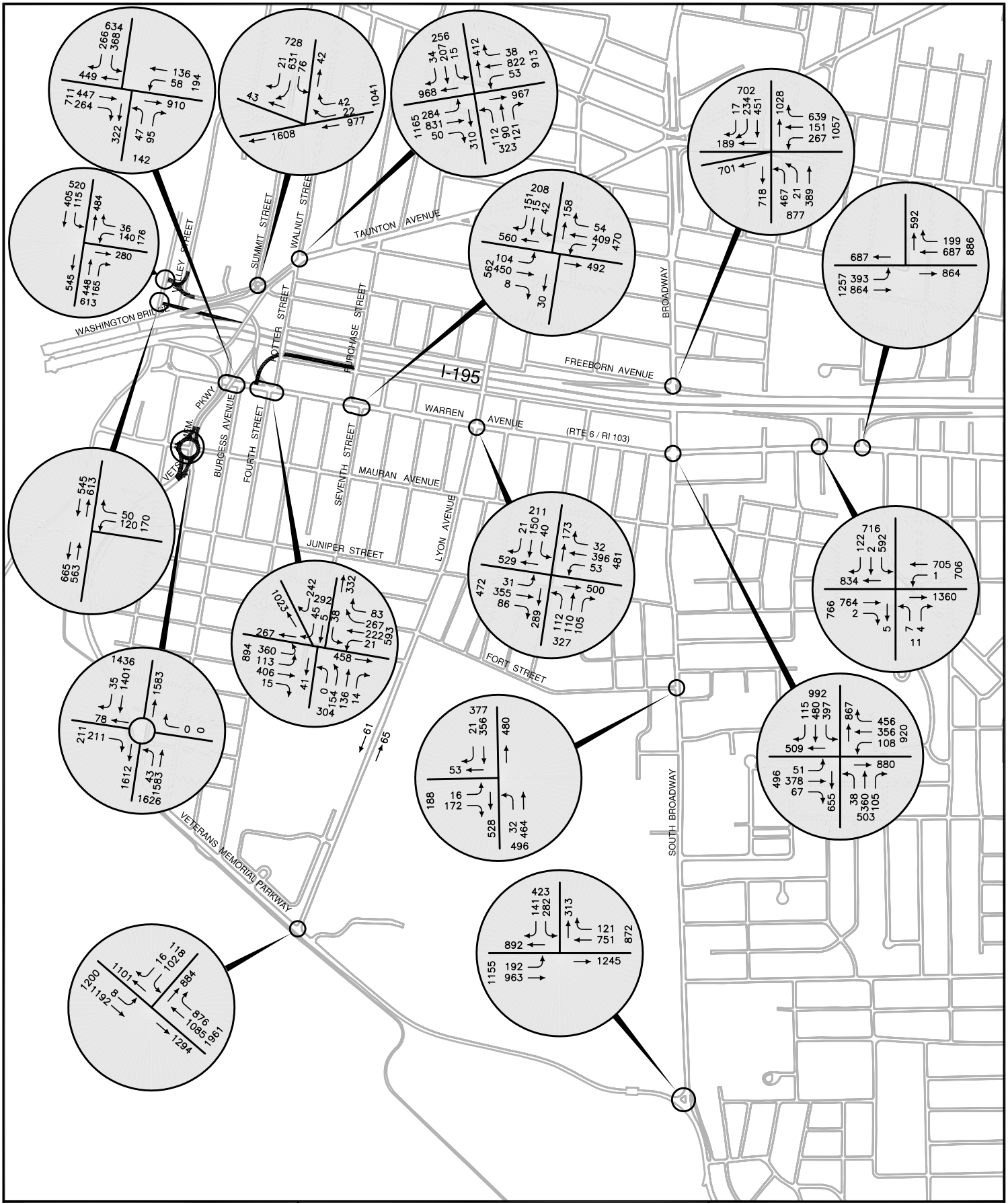
Interchange
East Providence, Rhode Island

2030 BUILD
WATERFRONT DRIVE 1 & 2
PM PEAK HOUR
4:30 - 5:30
FREEWAY VOLUMES

FIGURE 22



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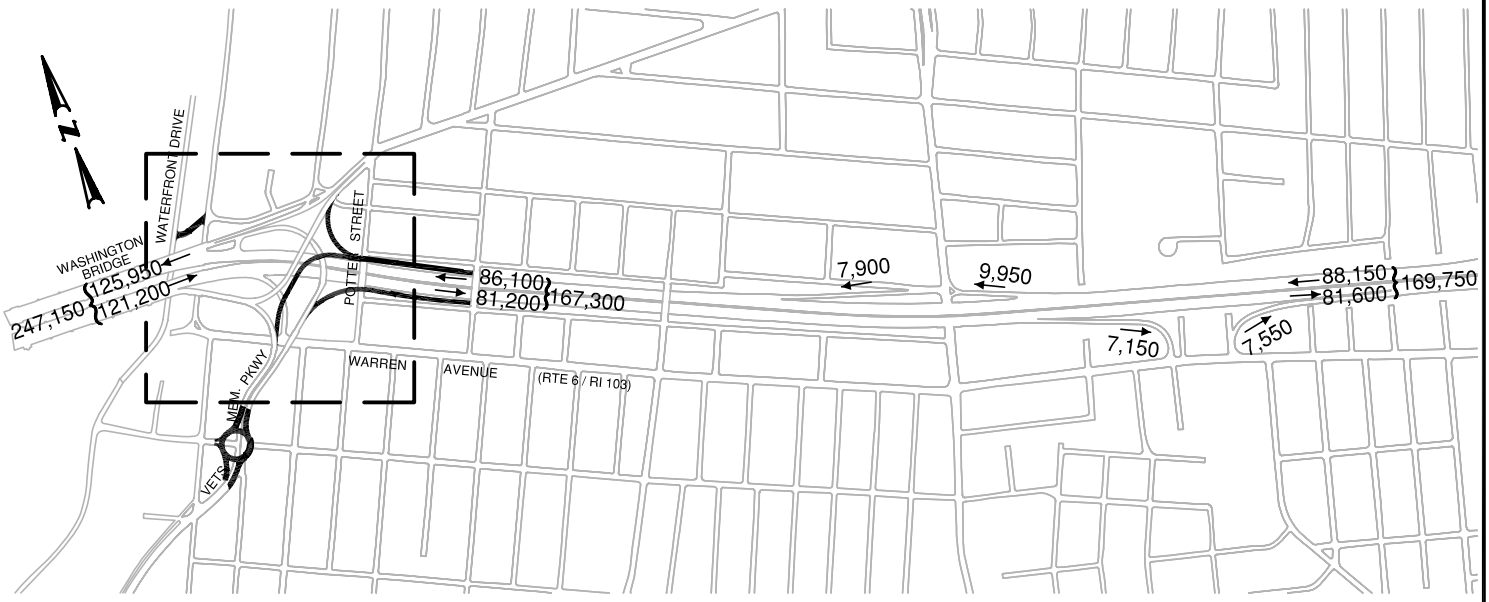
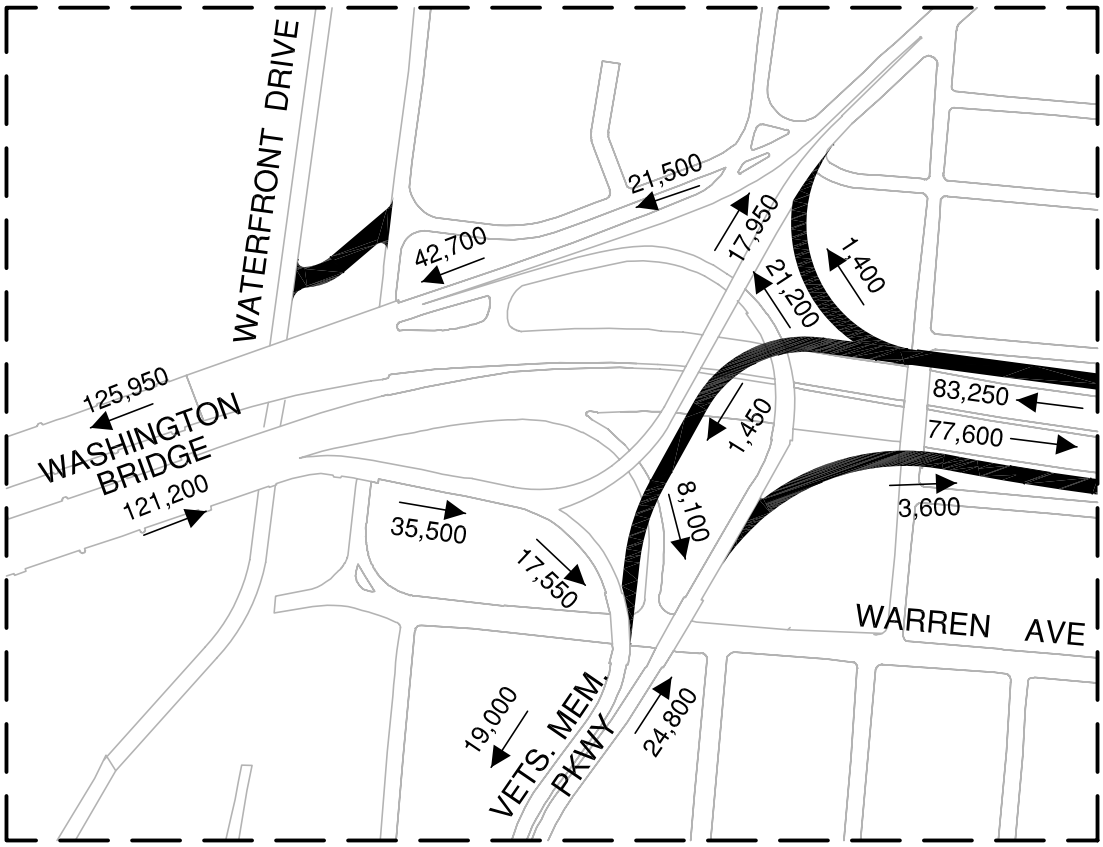
Interchange
East Providence, Rhode Island

2030 BUILD
WATERFRONT DRIVE 1 & 2
PM PEAK HOUR
4:30 - 5:30
INTERSECTION VOLUMES

FIGURE 23





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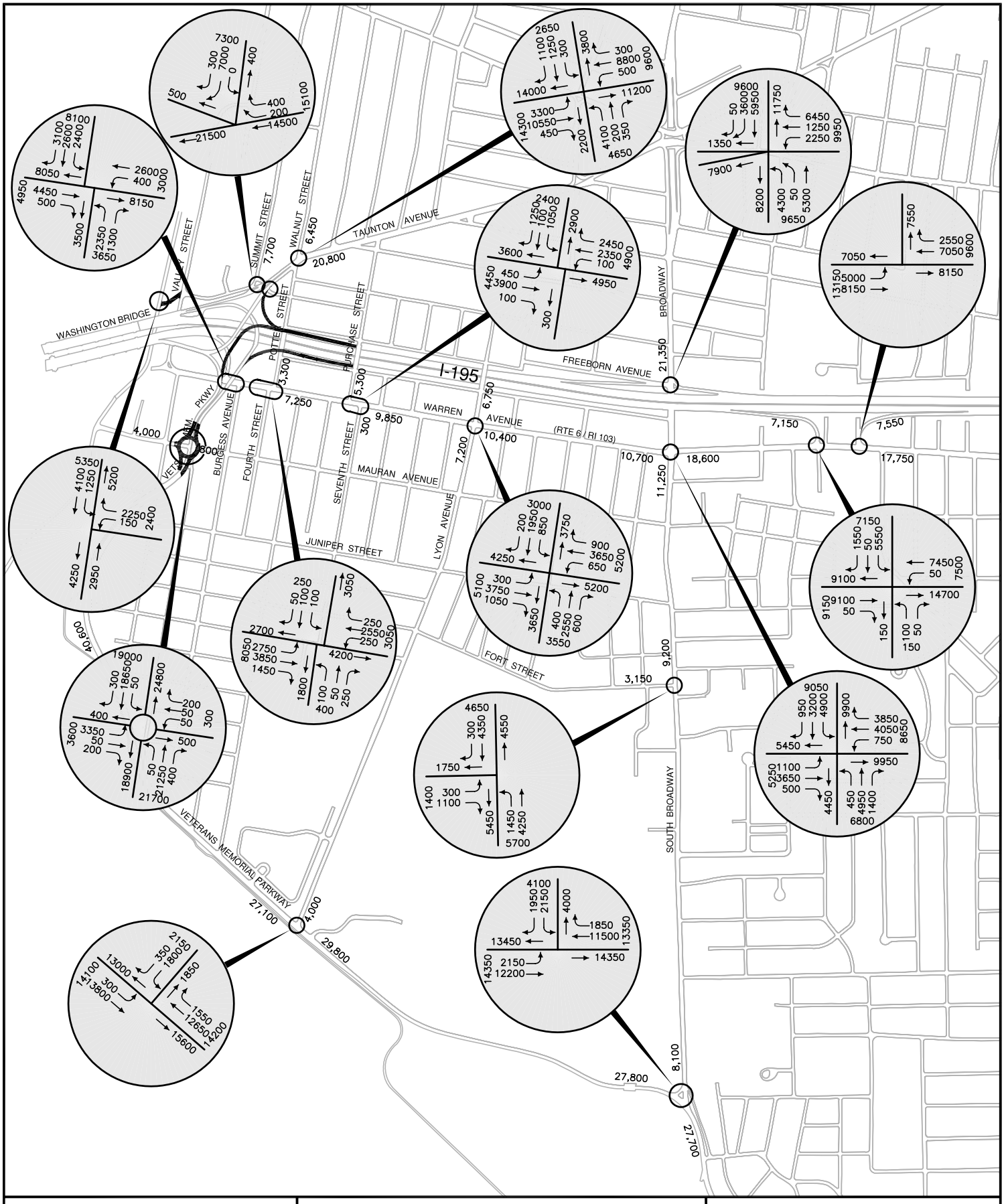
Improvements to the
I-195/Taunton Avenue/Warren Avenue
Interchange
East Providence, Rhode Island

2030 BUILD
VETERANS MEMORIAL
PARKWAY 1
AADT
FREEWAY VOLUMES

FIGURE 24



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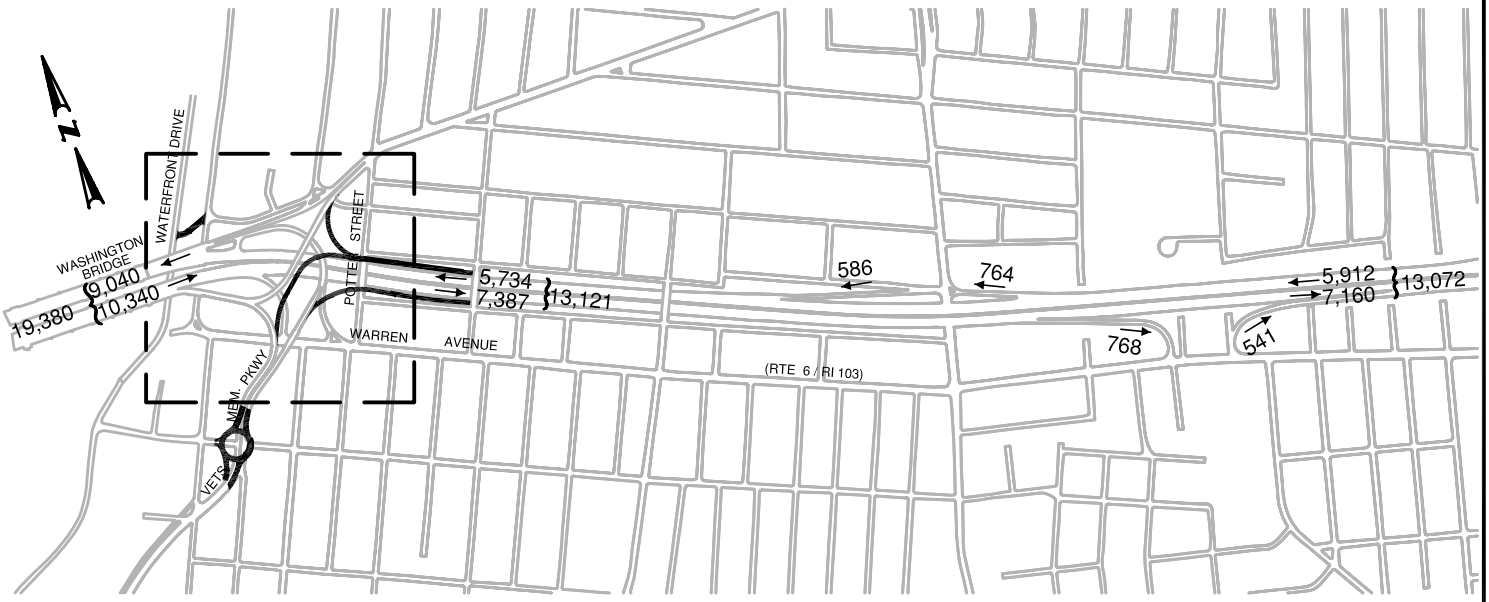
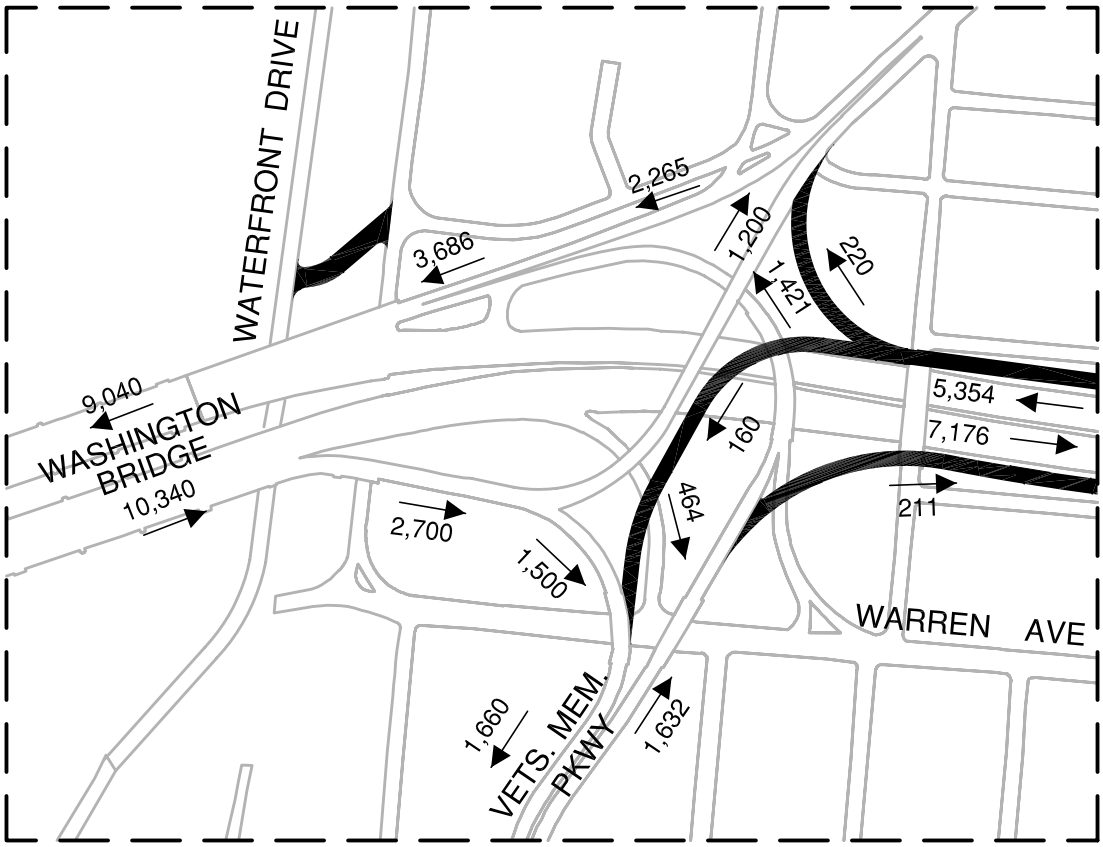
I-195/Taunton Avenue/Warren Avenue
Interchange
East Providence, Rhode Island

2030 BUILD
VETERANS MEMORIAL
PARKWAY 1
AADT
INTERSECTION VOLUMES

FIGURE 25





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Improvements to the
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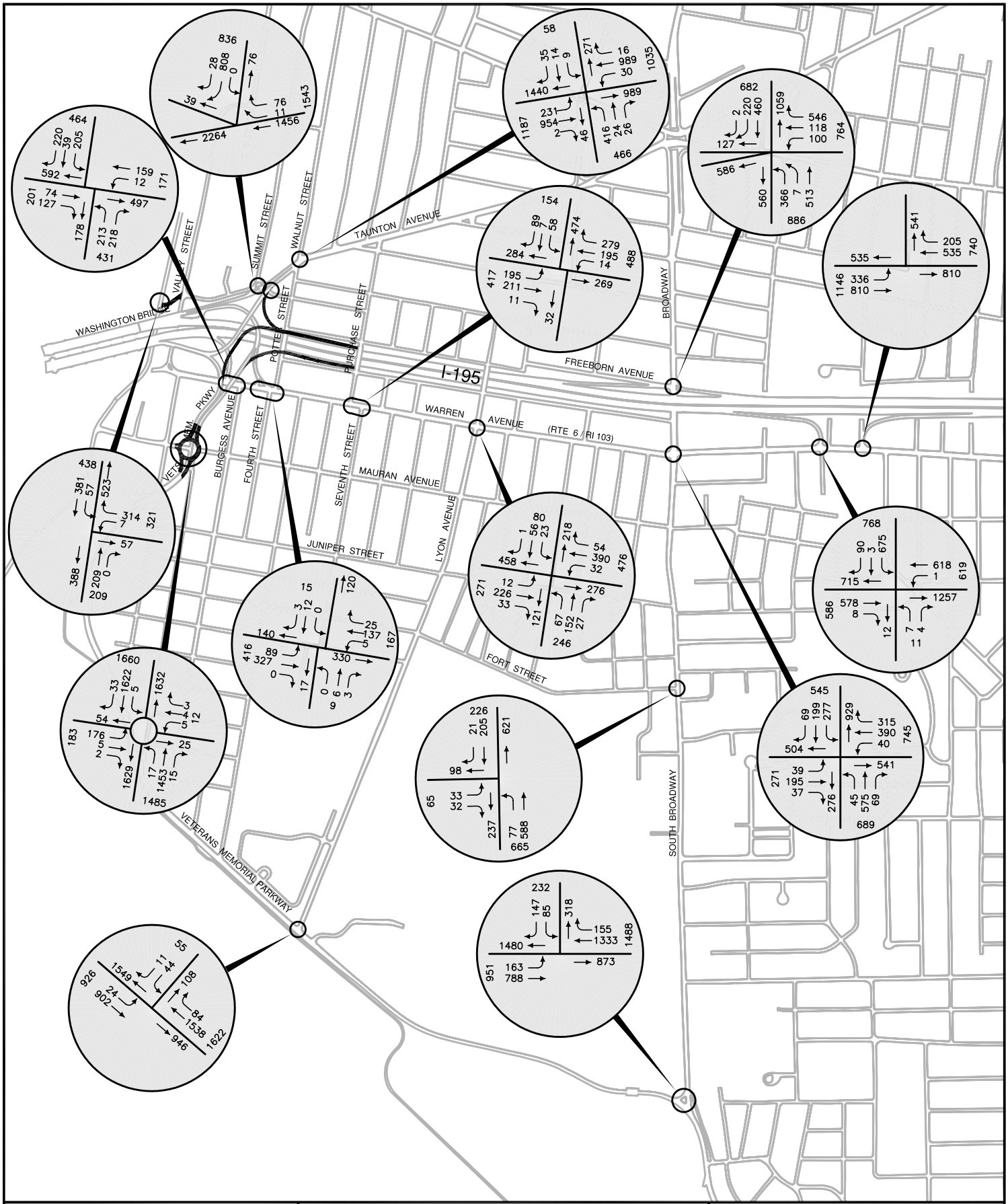
Interchange
East Providence, Rhode Island

2030 BUILD
VETERANS MEMORIAL
PARKWAY 1
AM PEAK 7:30 - 8:30
FREEWAY VOLUMES

FIGURE 26



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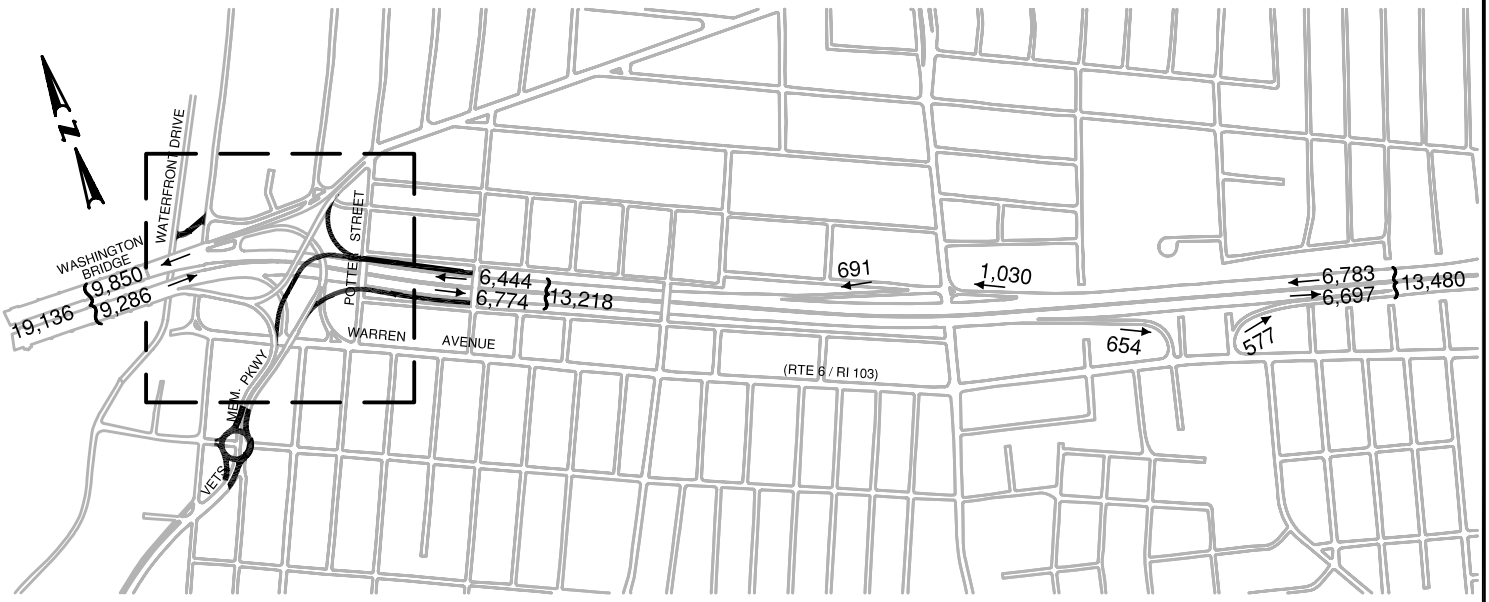
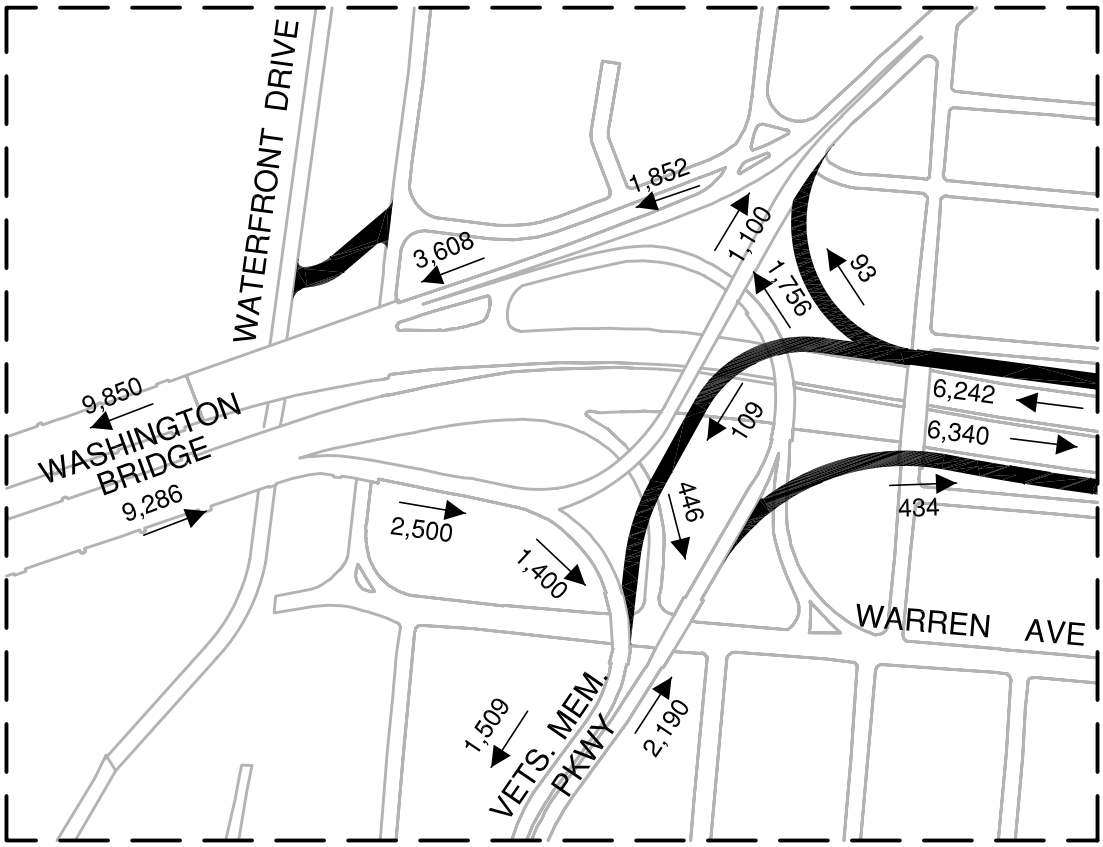
Interchange
East Providence, Rhode Island

2030 BUILD
VETERANS MEMORIAL
PARKWAY 1
AM PEAK 7:30 - 8:30
INTERSECTION VOLUMES

FIGURE 27





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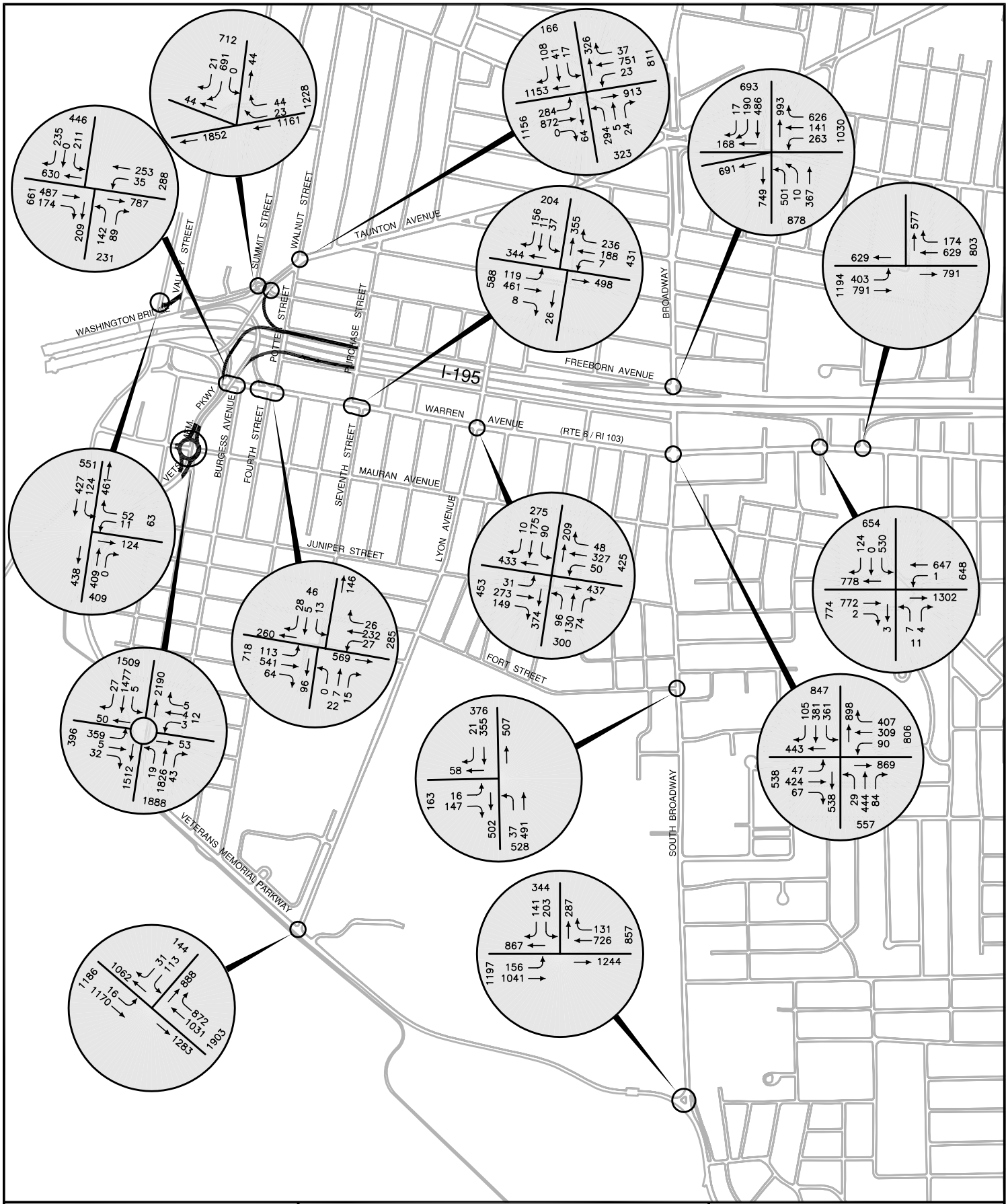
Interchange
East Providence, Rhode Island

2030 BUILD
VETERANS MEMORIAL
PARKWAY 1
PM PEAK 4:30 - 5:30
FREEWAY VOLUMES

FIGURE 28



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Improvements to the
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Interchange
East Providence, Rhode Island

2030 BUILD
VETERANS MEMORIAL
PARKWAY 1
PM PEAK 4:30 - 5:30
INTERSECTION VOLUMES

FIGURE 29

generally describes these conditions in terms of such factors as speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience, and safety.

For analysis purposes, level of service is expressed with letter designations as a range of A through F, with "A" representing the best conditions and "F" representing the worst. Level of service A can generally be described as a condition of free flow with very little delay experienced by the driver, and virtually no interference from other vehicles. Level of service F, on the other hand, is a forced flow condition, with "stop and go" traffic, excessive backups at traffic signals and undue delay and inconvenience to the motorists. Within these two extremes, level of service C represents a condition of stable operation.

Traffic analyses have been completed for the AM and PM peak hour traffic conditions under the following scenarios:

- 2004 Existing Conditions
- 2030 No-Build Condition
- 2030 Upgrade/TSM Alternative
- 2030 Waterfront Drive 1
- 2030 Waterfront Drive 2
- Veterans Memorial Parkway 1

Table 5
Comparison of Traffic Assignments

Location	2004 AADT Existing Condition	2030 AADT No-Build Condition	2030 AADT Waterfront Drive 1 or 2	2030 AADT Vet. Memorial Pkwy.
I-195 West of Interchange	171,200	246,550	247,300	247,150
Percentage Increase compared to 2004		44%	44%	44%
Percent increase per year		1.41%	1.42%	1.42%
I-195 East of Interchange	117,000	160,200	168,250	167,300
Percentage Increase compared to 2004		37%	44%	43%
Percent increase per year		1.22%	1.41%	1.38%
I-195/Taunton Ave/Warren Ave Interchange				
I-195 EB off-ramp	20,300	34,100	35,200	35,500
I-195 WB on-ramp	30,400	43,600	43,300	42,700
Sum of existing ramps	50,700	77,700	78,500	78,200
Percentage Increase compared to 2004		53%	55%	54%
Percent increase per year		1.66%	1.70%	1.68%
New I-195 EB on-ramp			6,150	3,600
New I-195 WB off-ramp			2,250	2,850
Sum of new ramps			8,400	6,450
I-195/Warren Avenue/Broadway Interchange				
I-195 WB off-ramp	7,700	12,200	10,600	9,950
I-195 EB on-ramp	6,700	9,700	7,000	7,550
Total Ramp Volumes	14,400	21,900	17,600	17,500
Percentage Decrease of 2030 Build vs. no-build			20%	20%
Warren Avenue				
Btw. Potter Street & Purchase Street	9,800	13,900	12,200	7,050
Btw. Purchase Street & Lyon Avenue	9,900	12,050	9,900	9,600
Btw. Lyon Avenue & Broadway	9,400	12,500	10,400	10,550
Btw. Broadway & I-195 EB ramps	16,900	19,200	18,300	18,400
Avg. decrease in traffic compared to 2030 No-build			1,700	3,000

Capacity Analyses for Intersections

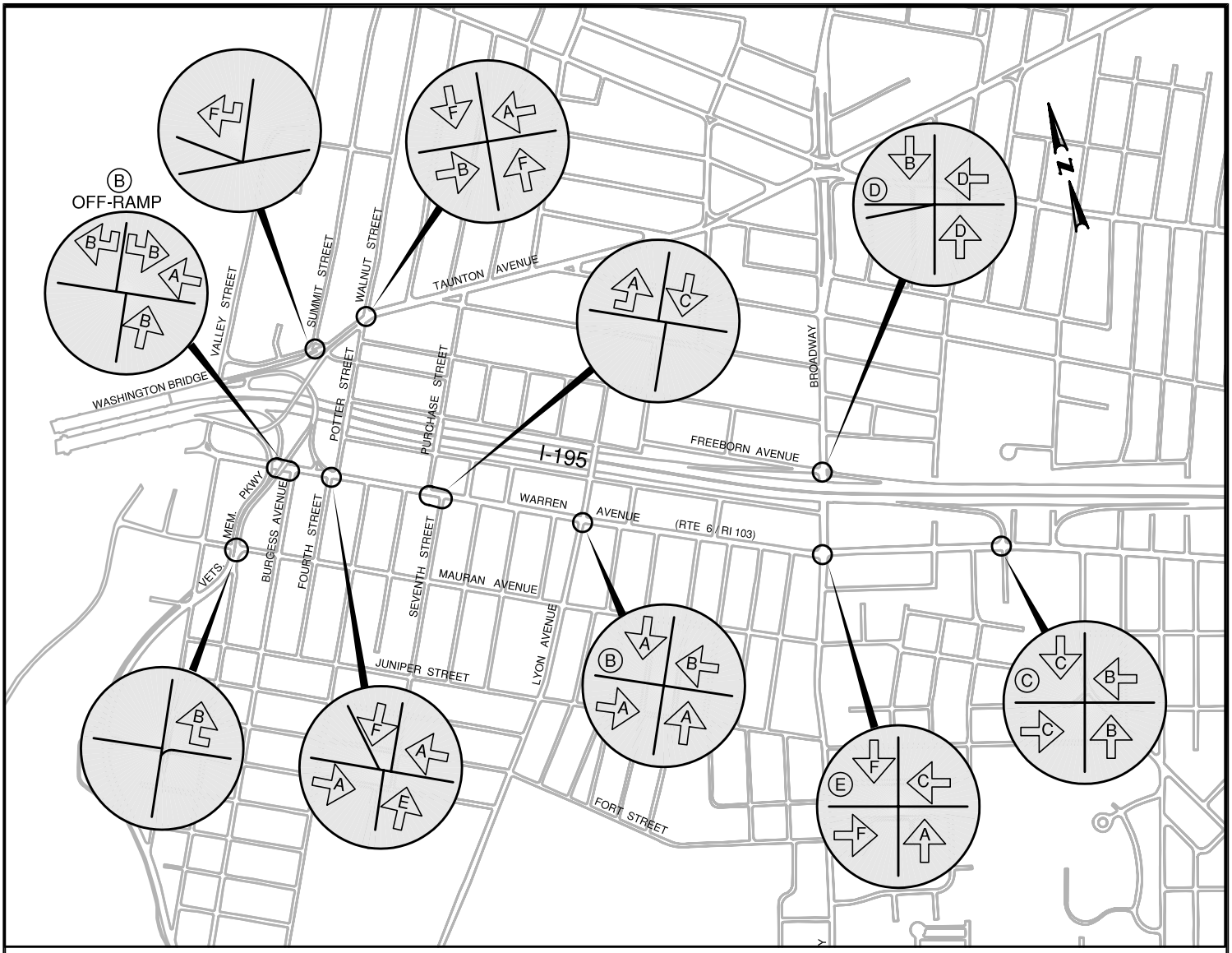
Level of service (LOS) at an intersection is based upon the vehicle delay. At a signalized intersection, LOS is as follows:

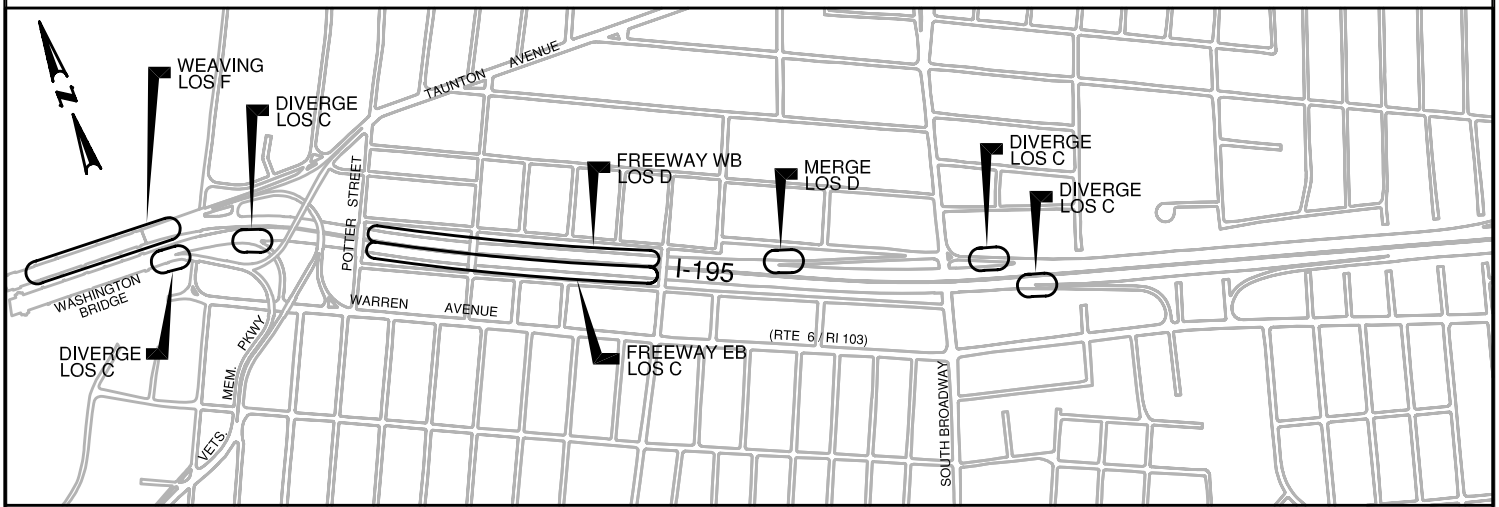
LOS A - less than 10 seconds
LOS B - 10-20 seconds
LOS C - 20-35 seconds
LOS D - 35-55 seconds
LOS E - 55-80 seconds
LOS F - greater than 80 seconds

The delay range for each LOS at an unsignalized intersection is as follows:

LOS A - less than 10 seconds
LOS B - 10-15 seconds
LOS C - 15-25 seconds
LOS D - 25-35 seconds
LOS E - 35-50 seconds
LOS F - greater than 50 seconds

A summary of the intersection capacity analysis results for the AM peak hour condition is shown in Table 6 for the unsignalized intersections and in Table 7 for the signalized intersections. Similarly, the results of the intersection capacity analyses for the PM peak hour are shown in Tables 8 and 9. Figures 30 thru 39 display the results of the capacity analyses.





(E) LEVEL OF SERVICE FOR OVERALL INTERSECTION

(A) LEVEL OF SERVICE FOR APPROACH

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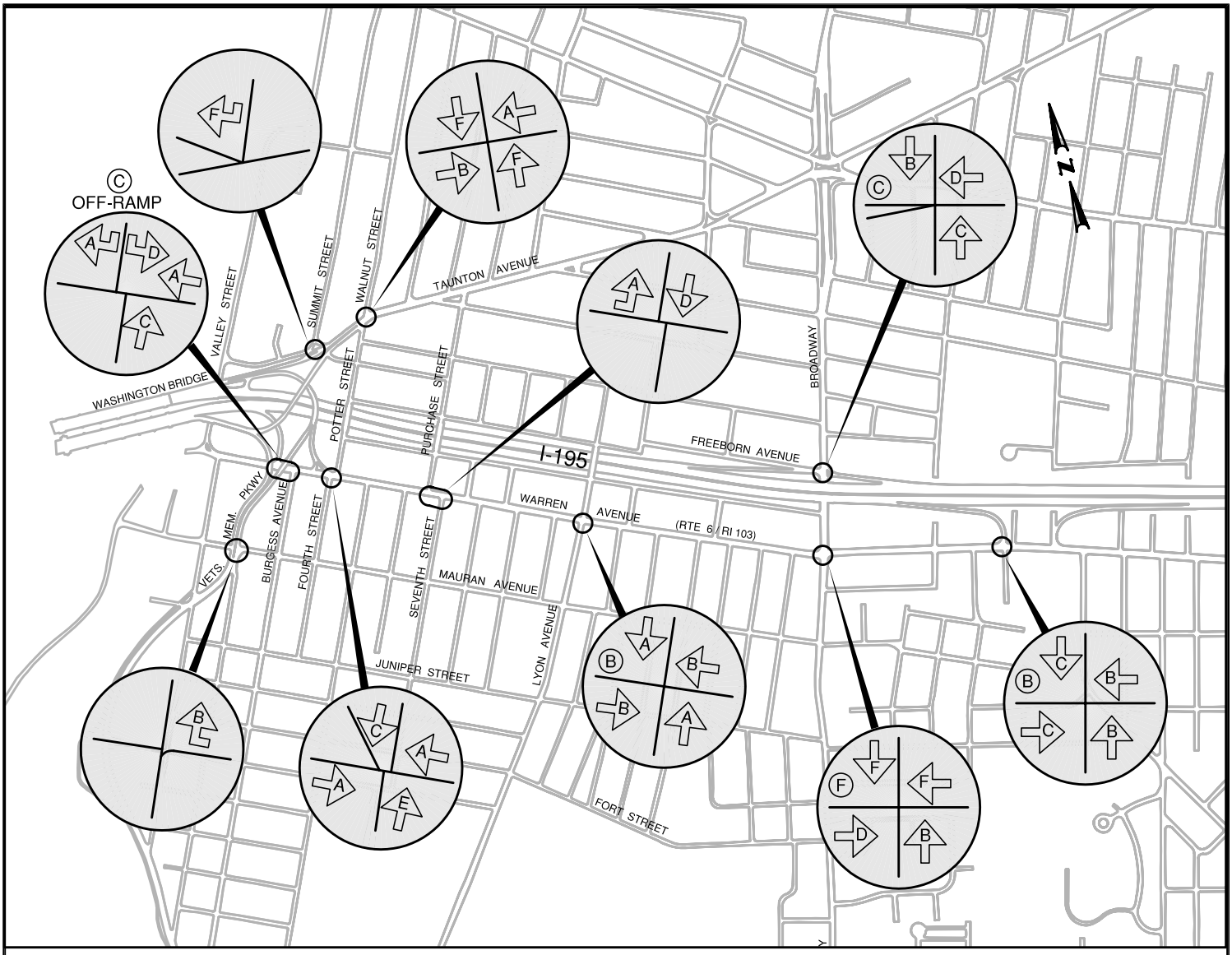
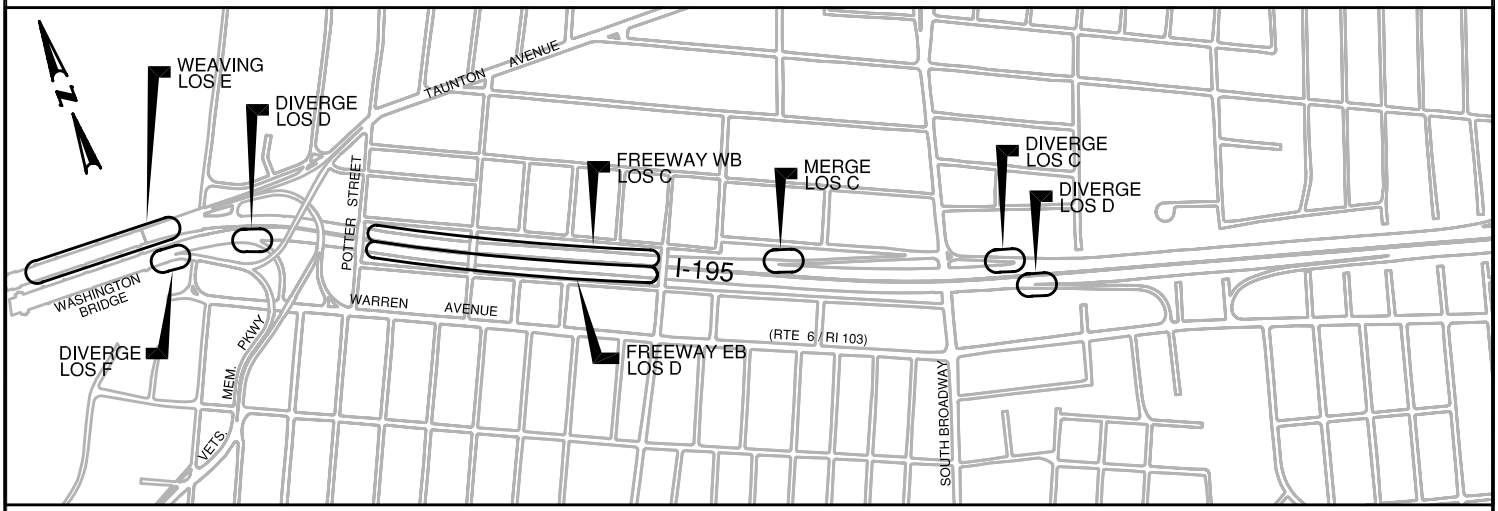
Improvements to the
I-195/Taunton Avenue/Warren Avenue
Interchange
East Providence, Rhode Island

2004
EXISTING CONDITIONS
LEVEL OF SERVICE
AM PEAK HOUR

FIGURE 30





(E) LEVEL OF SERVICE FOR OVERALL INTERSECTION

(A) LEVEL OF SERVICE FOR APPROACH

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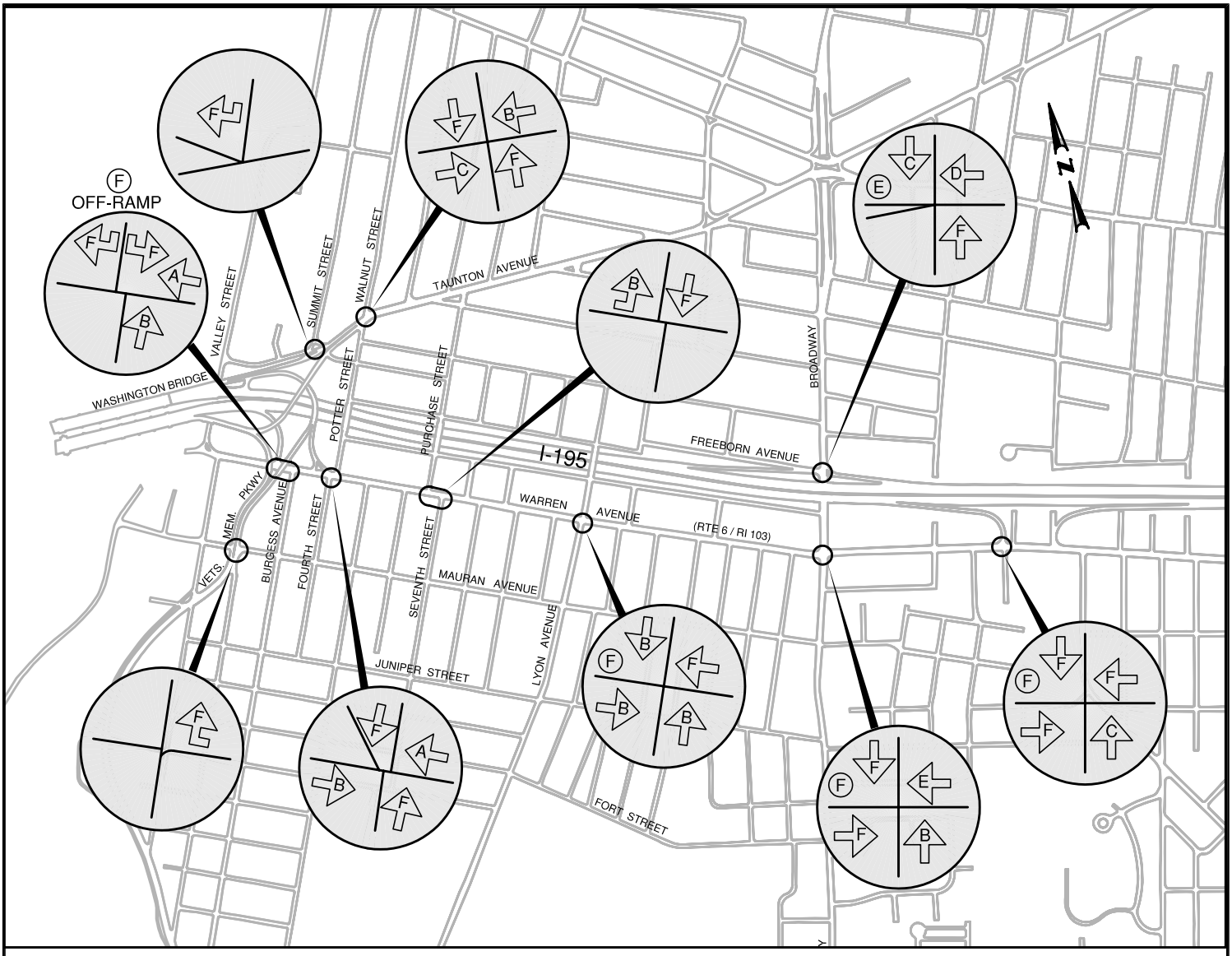
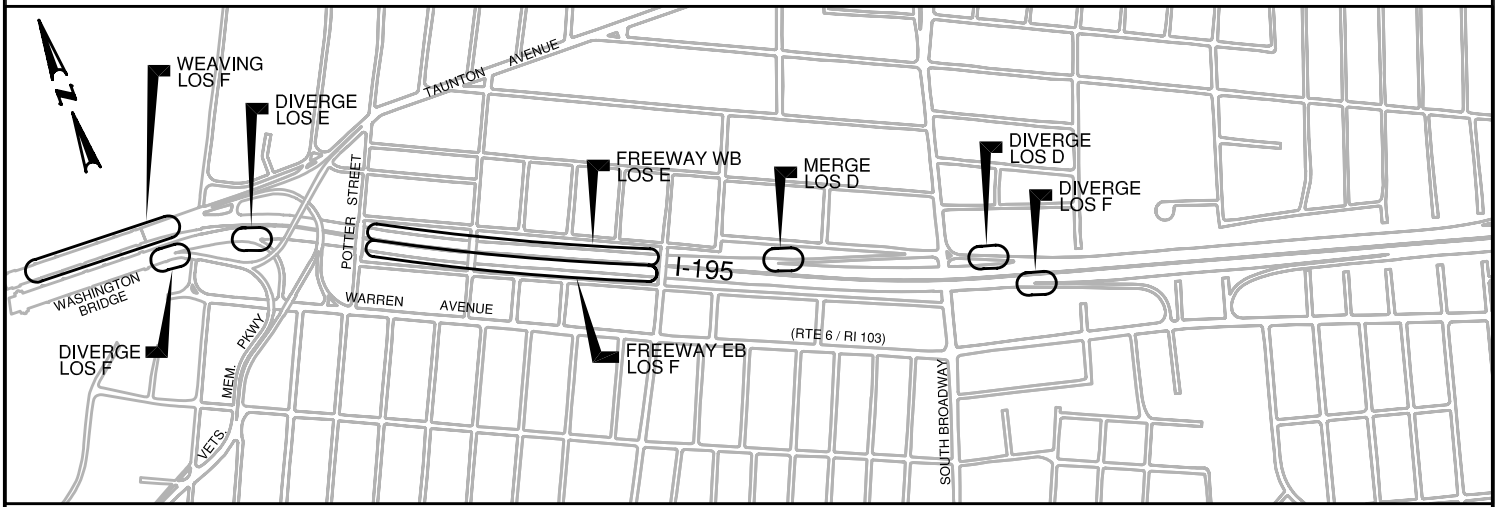
I-195/Taunton Avenue/Warren Avenue
Interchange
East Providence, Rhode Island

2004 EXISTING CONDITIONS

LEVEL OF SERVICE PM PEAK HOUR

FIGURE 31





(E) LEVEL OF SERVICE FOR OVERALL INTERSECTION

(A) LEVEL OF SERVICE FOR APPROACH

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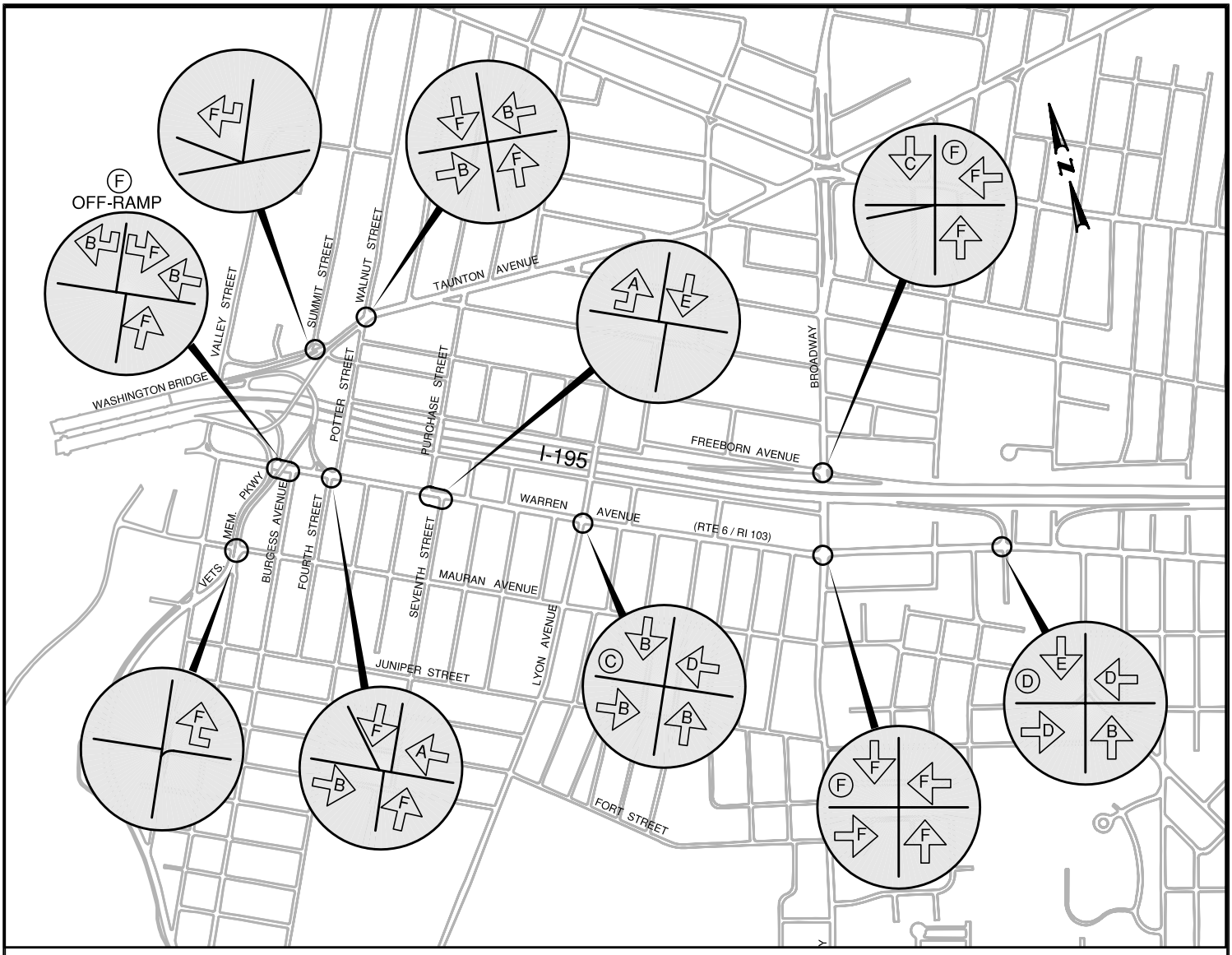
Professional Engineers

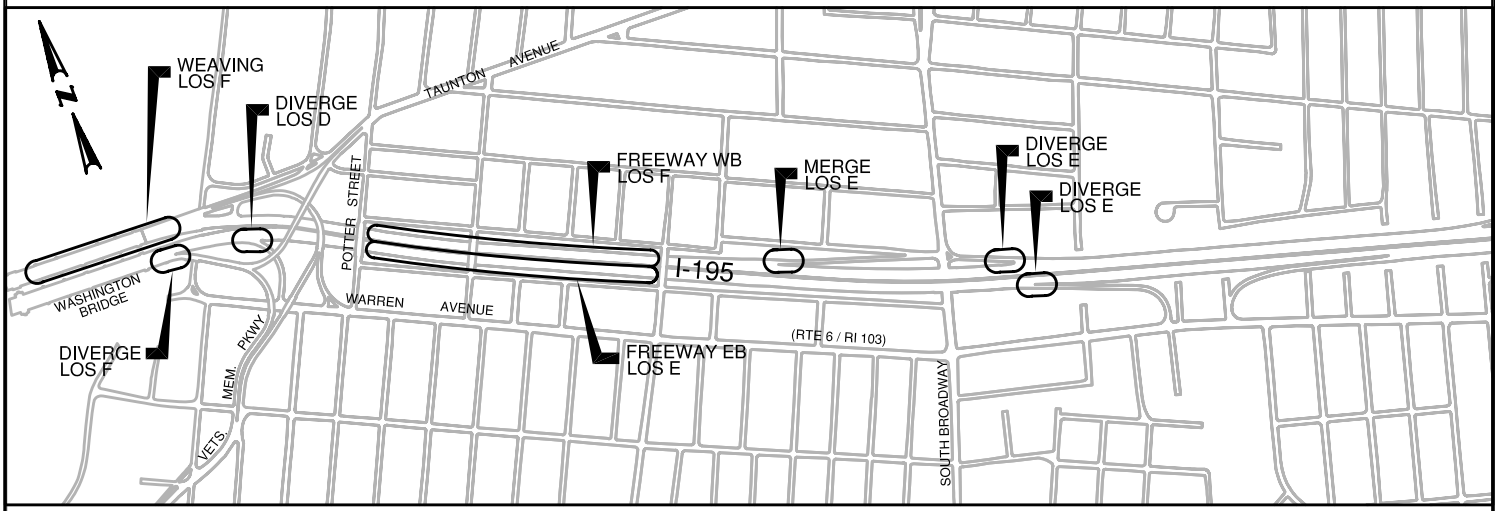
Improvements to the
I-195/Taunton Avenue/Warren Avenue
Interchange
East Providence, Rhode Island

2030 NO BUILD

LEVEL OF SERVICE AM PEAK HOUR

FIGURE 32





(E) LEVEL OF SERVICE FOR OVERALL INTERSECTION

(A) LEVEL OF SERVICE FOR APPROACH

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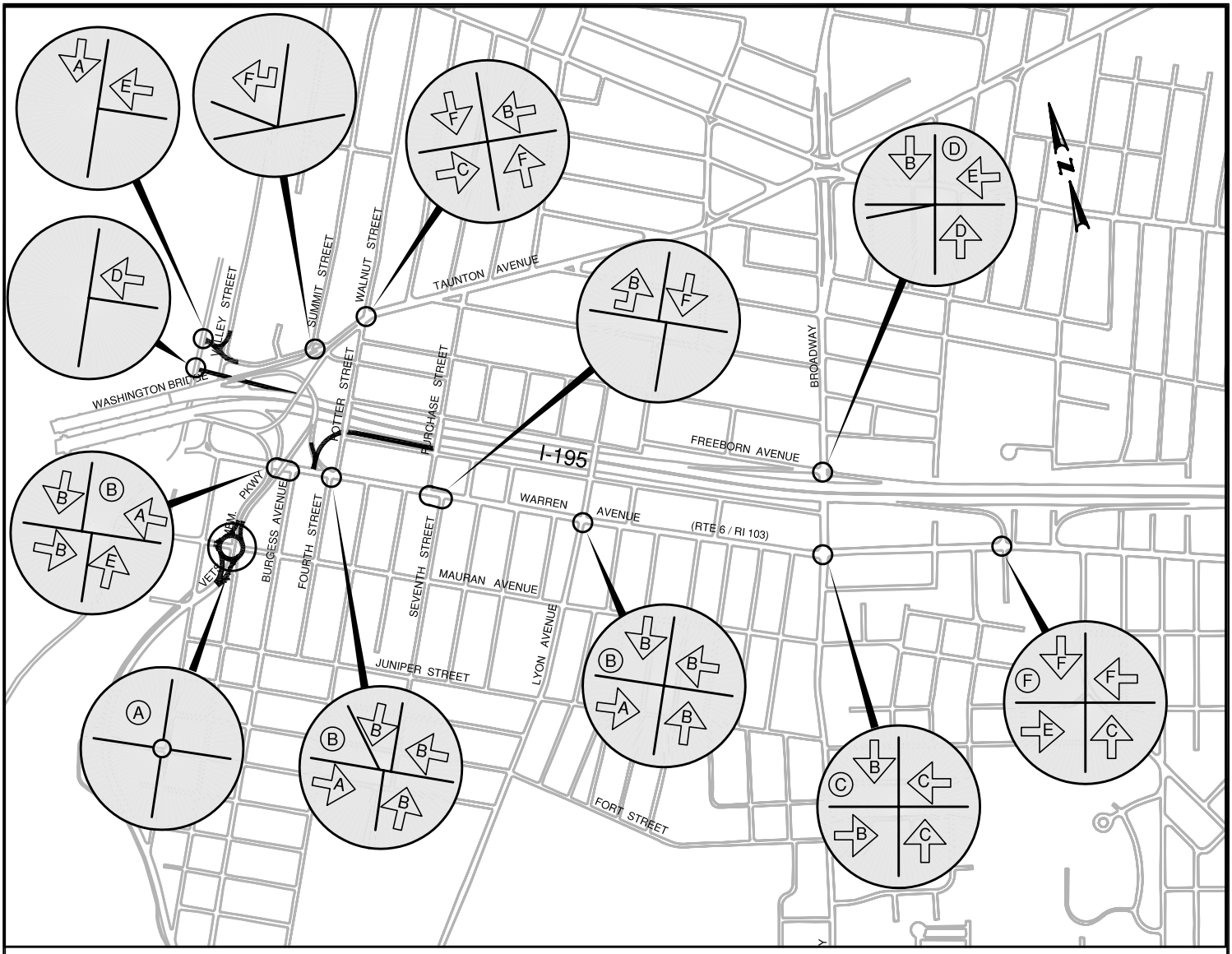
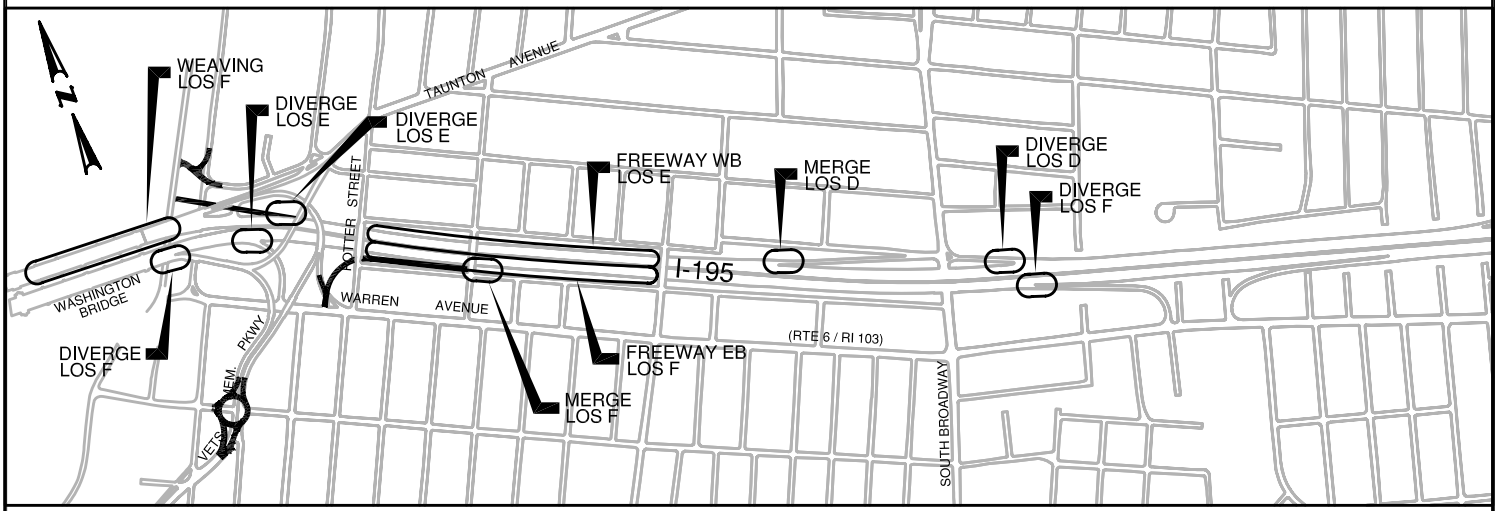
Improvements to the
I-195/Taunton Avenue/Warren Avenue
Interchange
East Providence, Rhode Island

2030 NO BUILD

LEVEL OF SERVICE
PM PEAK HOUR

FIGURE 33





(E) LEVEL OF SERVICE FOR OVERALL INTERSECTION

(A) LEVEL OF SERVICE FOR APPROACH

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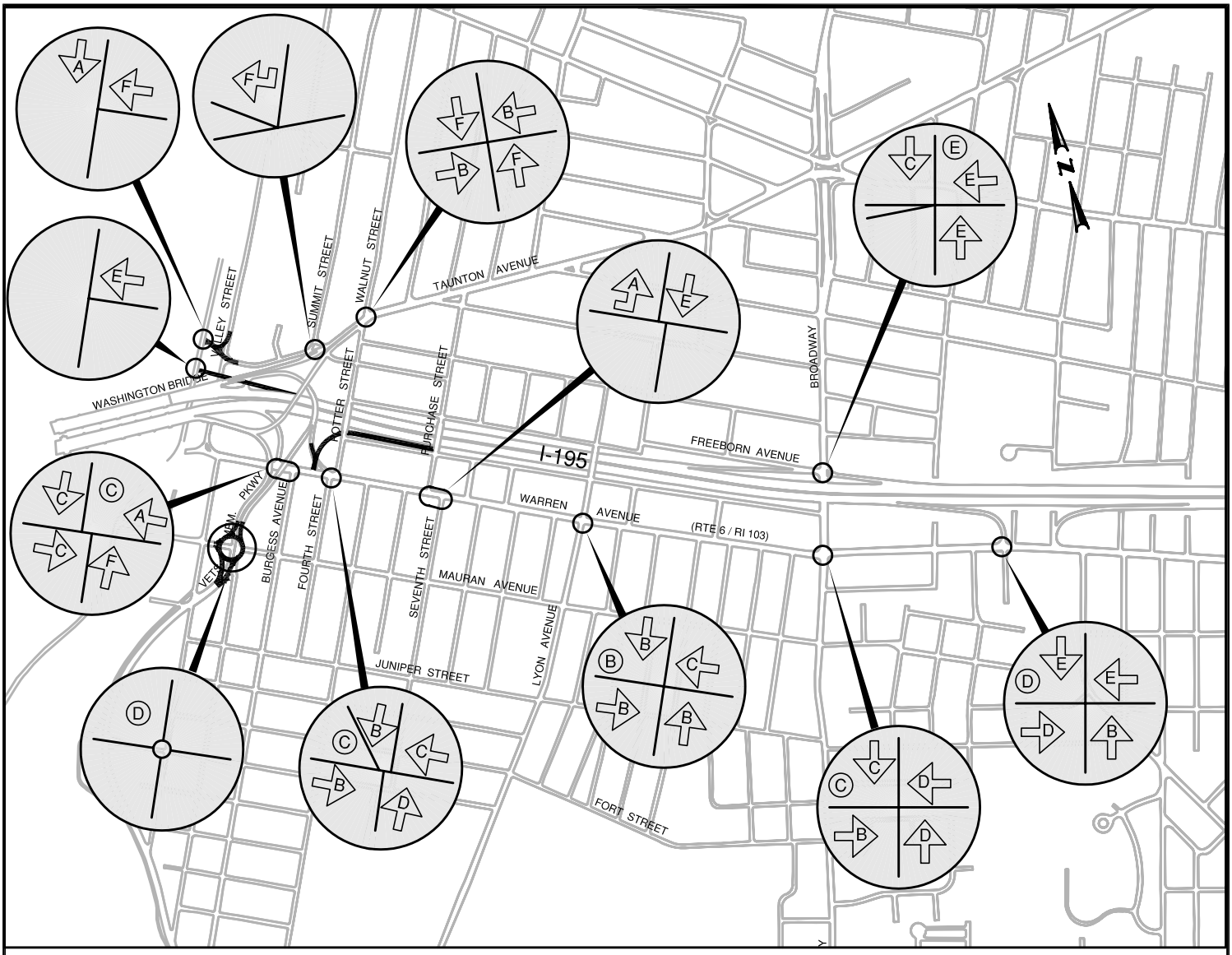
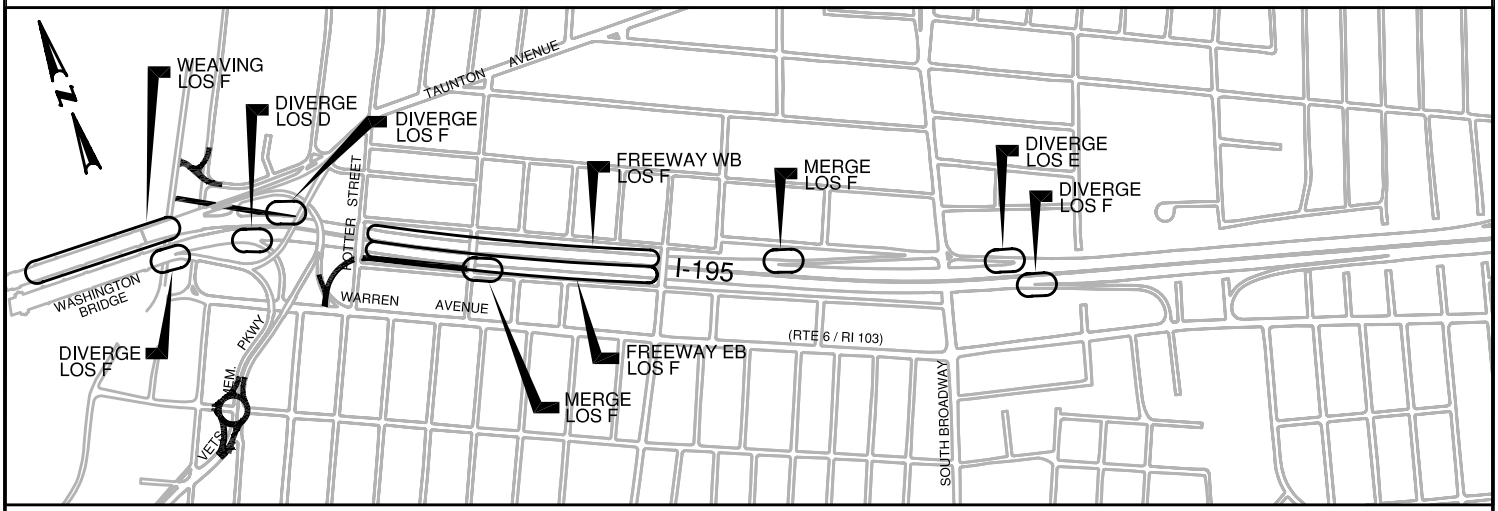
Improvements to the
I-195/Taunton Avenue/Warren Avenue
Interchange
East Providence, Rhode Island

2030 BUILD WATERFRONT DR. 1

LEVEL OF SERVICE AM PEAK HOUR

FIGURE 34





(E) LEVEL OF SERVICE FOR OVERALL INTERSECTION

(A) LEVEL OF SERVICE FOR APPROACH

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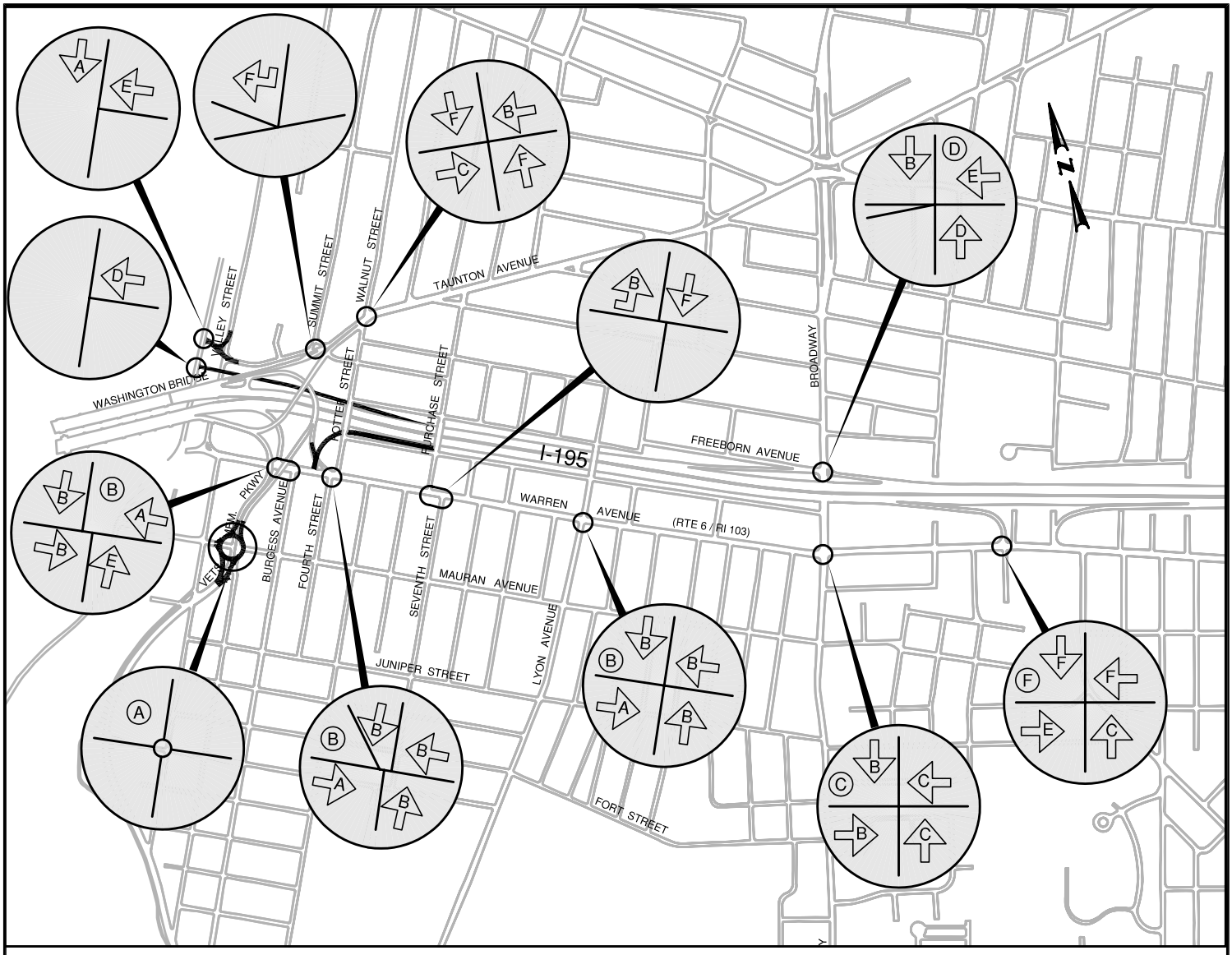
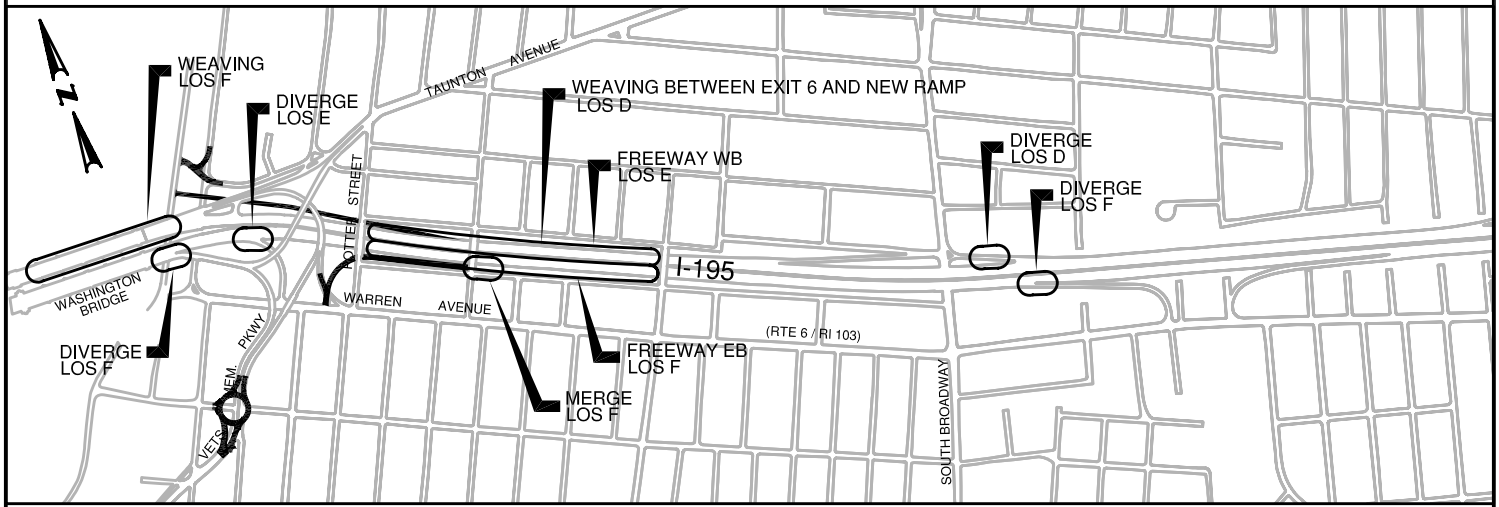
Improvements to the
I-195/Taunton Avenue/Warren Avenue
Interchange
East Providence, Rhode Island

2030 BUILD WATERFRONT DR. 1

LEVEL OF SERVICE PM PEAK HOUR

FIGURE 35





(E) LEVEL OF SERVICE FOR OVERALL INTERSECTION

(A) LEVEL OF SERVICE FOR APPROACH

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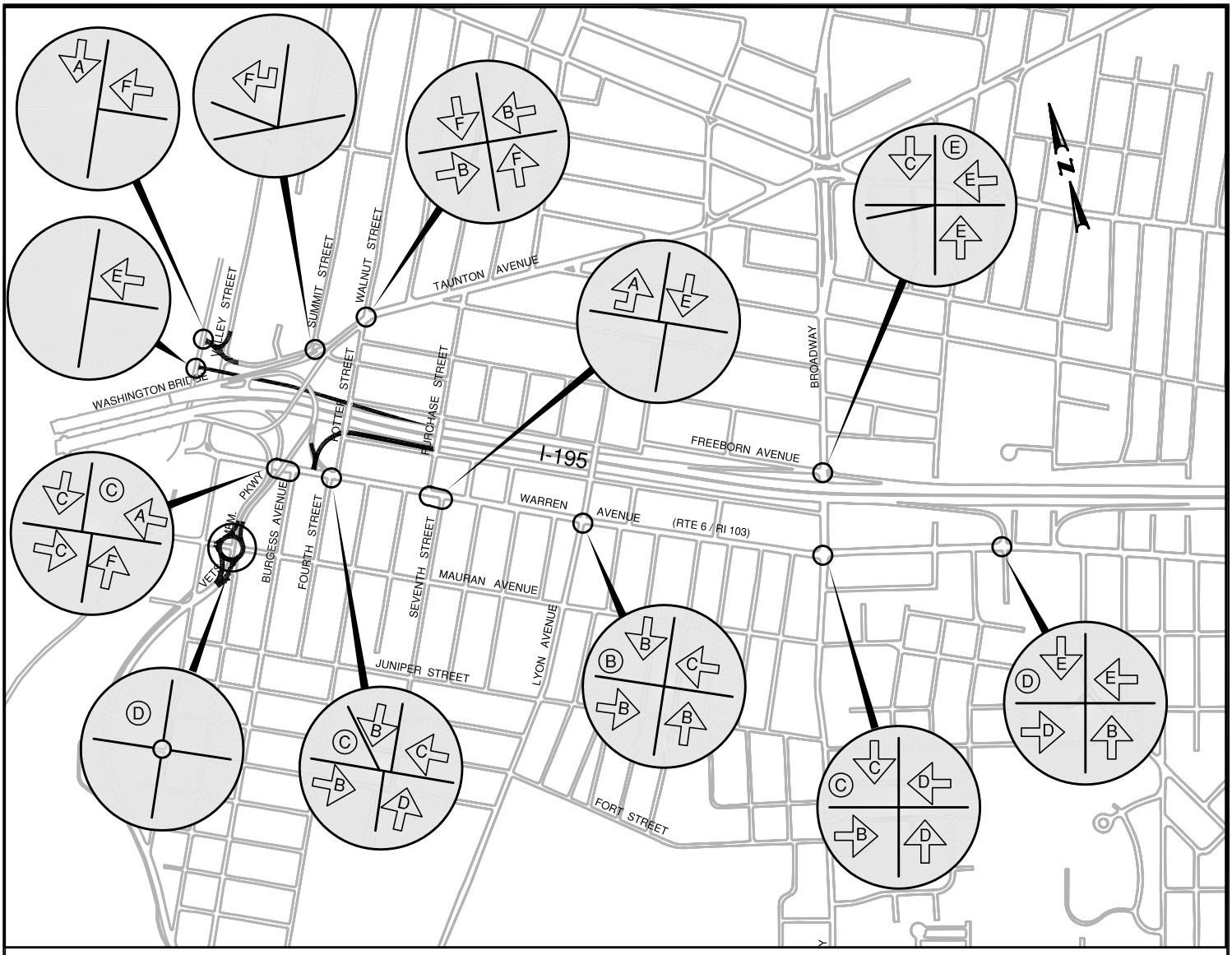
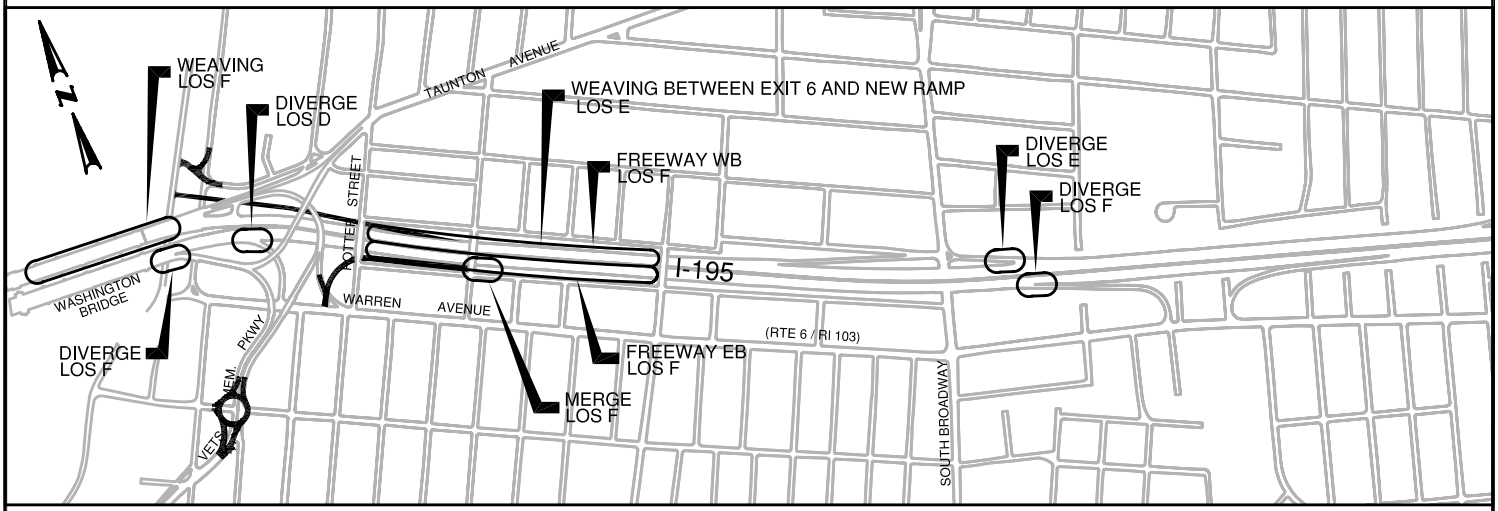
Improvements to the
I-195/Taunton Avenue/Warren Avenue
Interchange
East Providence, Rhode Island

2030 BUILD WATERFRONT DR. 2

LEVEL OF SERVICE AM PEAK HOUR

FIGURE 36





(E) LEVEL OF SERVICE FOR OVERALL INTERSECTION

(A) LEVEL OF SERVICE FOR APPROACH

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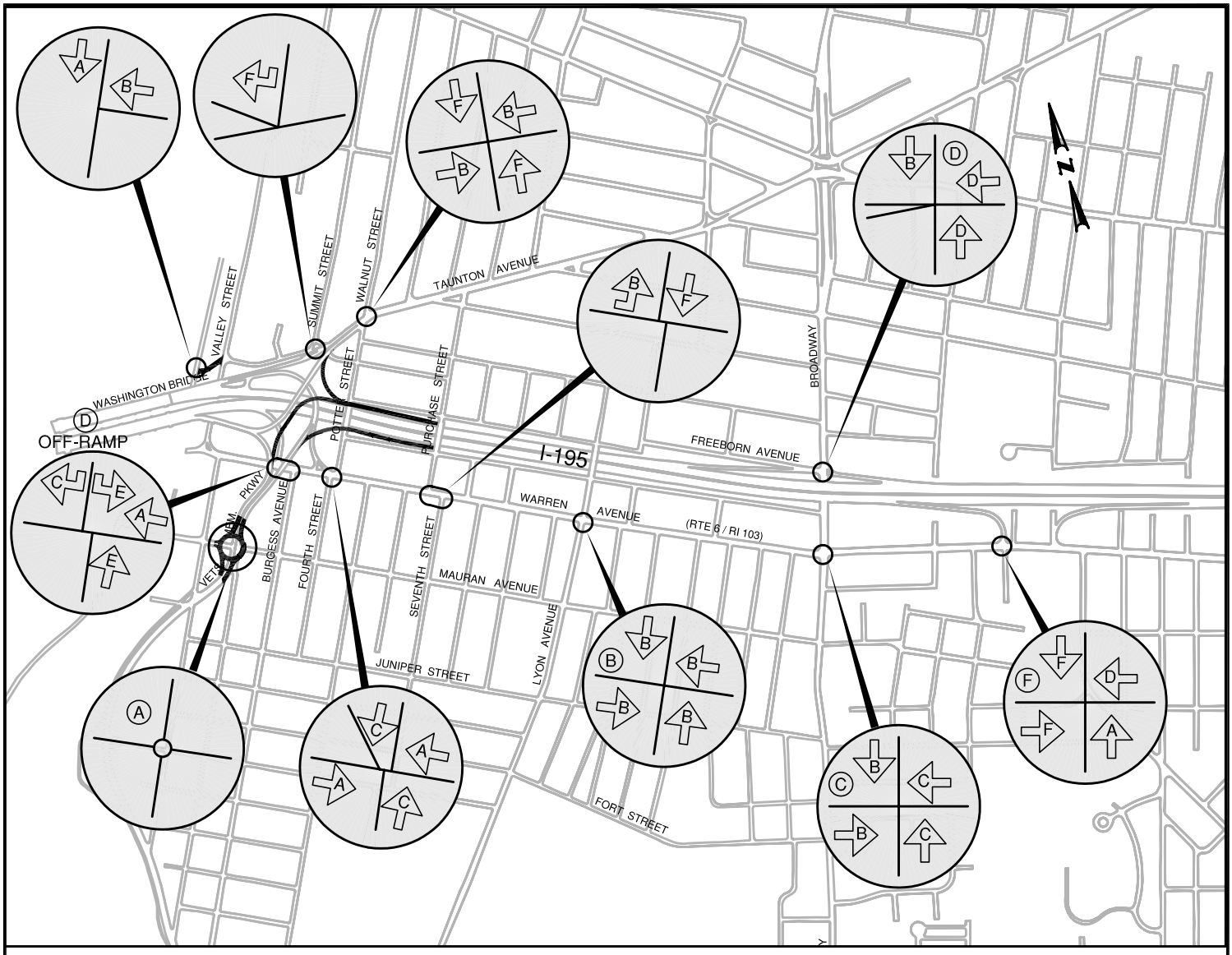
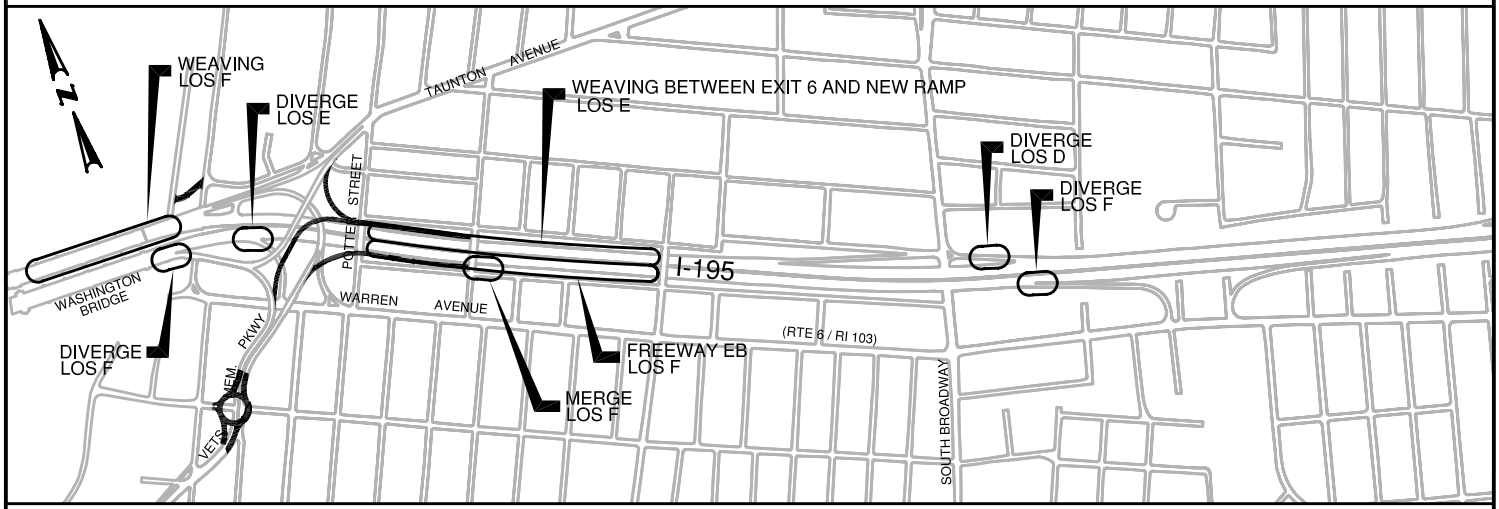
Improvements to the
I-195/Taunton Avenue/Warren Avenue
Interchange
East Providence, Rhode Island

2030 BUILD WATERFRONT DR. 2

LEVEL OF SERVICE PM PEAK HOUR

FIGURE 37





E LEVEL OF SERVICE FOR OVERALL INTERSECTION

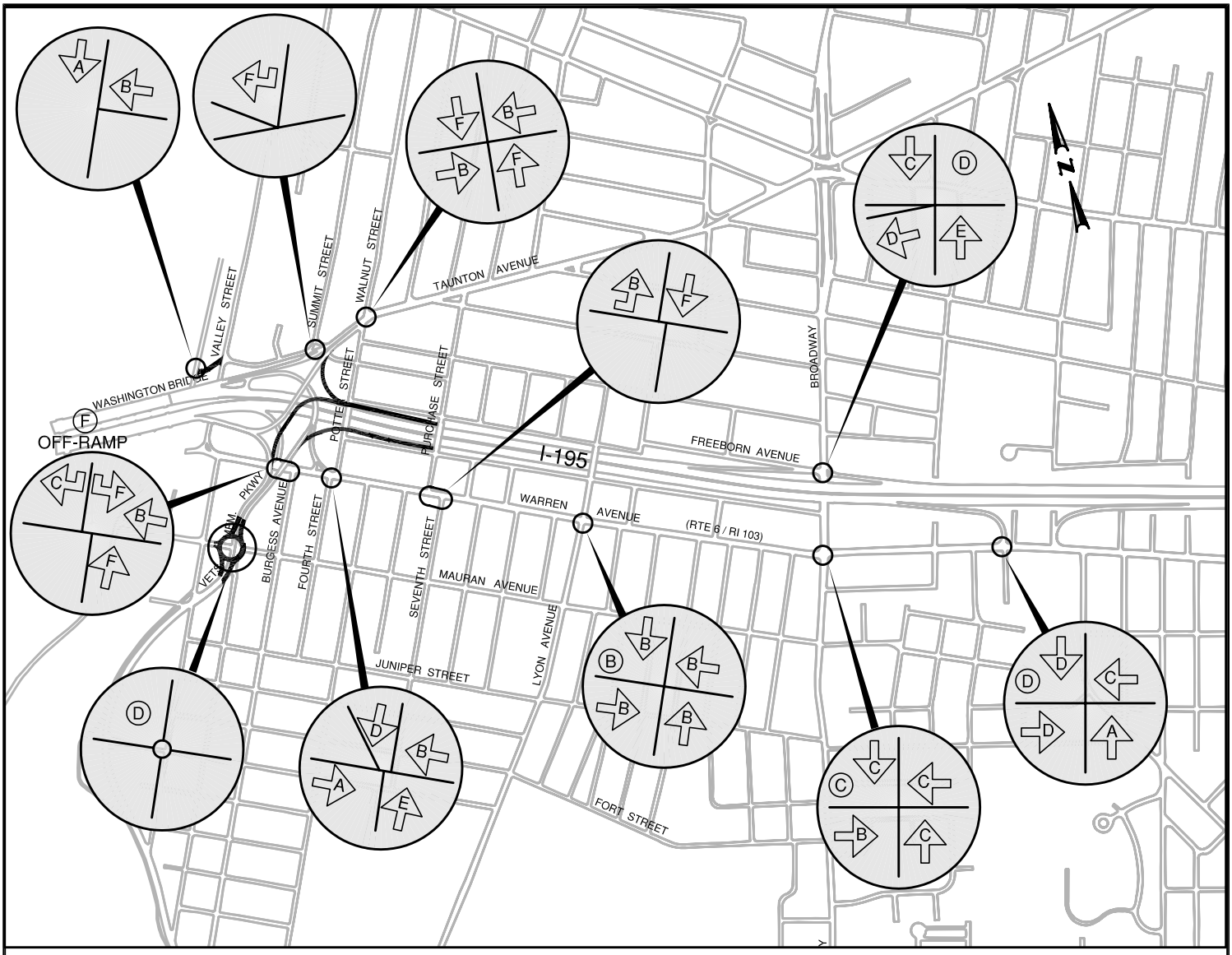
A LEVEL OF SERVICE FOR APPROACH

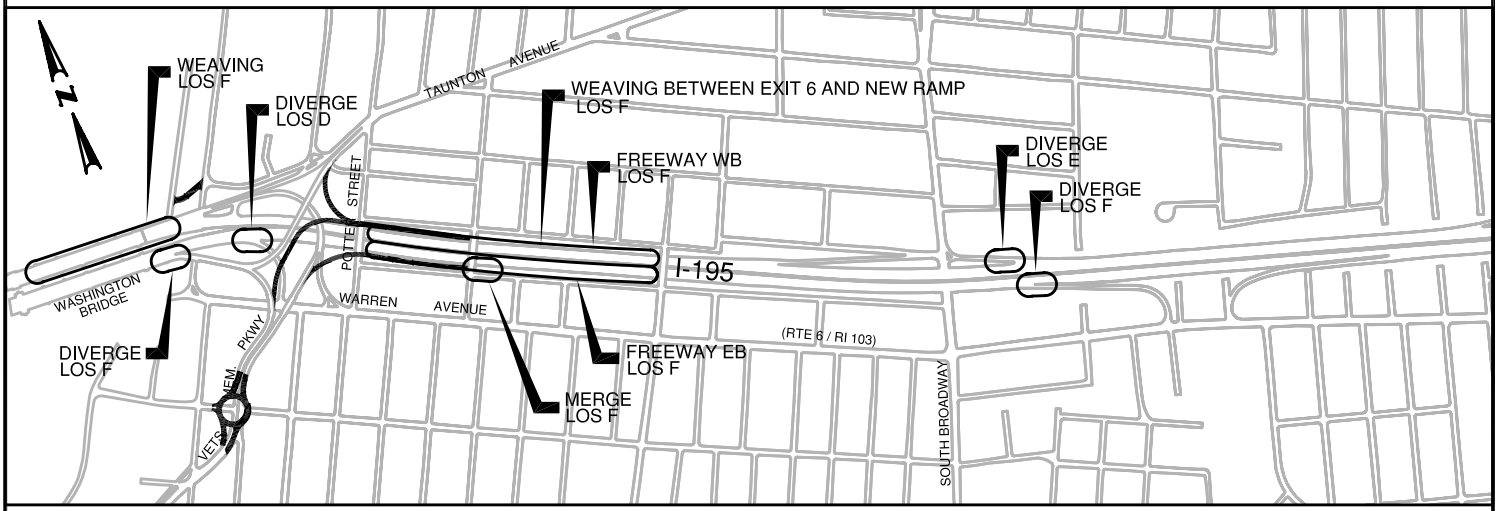
Gordon R. Archibald, Inc.
Professional Engineers

Improvements to the
I-195/Taunton Avenue/Warren Avenue
Interchange
East Providence, Rhode Island

2030 BUILD
VETERANS MEMORIAL PARKWAY
LEVEL OF SERVICE
AM PEAK HOUR

FIGURE 38





(E) LEVEL OF SERVICE FOR OVERALL INTERSECTION

(A) LEVEL OF SERVICE FOR APPROACH

Gordon R. Archibald, Inc.
Professional Engineers

Improvements to the
I-195/Taunton Avenue/Warren Avenue
Interchange
East Providence, Rhode Island

2030 BUILD VETERANS MEMORIAL PARKWAY

LEVEL OF SERVICE PM PEAK HOUR

FIGURE 39

Table 6
SUMMARY OF UNSIGNALIZED INTERSECTION CAPACITY ANALYSIS RESULTS
AM PEAK HOUR

UNSIGNALIZED INTERSECTIONS	LEVEL OF SERVICE/AVG. TOTAL DELAY(Sec./Veh.) 2004 EXISTING	2030 NO-BUILD	Upgrade/ TSM Alt.	Waterfront Dr 1& 2	Vet. Mem. Pkwy
1. MAURAN/VET. MEM. PKWY					
MAURAN AVE. EB RIGHT	B/14.2	F/65.6	F/65.6		
ROUNDABOUT				A/7.0	B/11.2
2. TAUNTON/WALNUT					
TAUNTON AVE. EB	B/12.8	C/15.7	C/15.7	C/15.3	B/14.1
TAUNTON AVE. WB	A/9.5	B/11.8	B/11.8	B/13.0	B/11.6
WALNUT ST. NB	F/*	F/*	F/*	F/*	F/*
WALNUT ST.SB	F/*	F/*	F/*	F/*	F/*
* indicates that delay cannot be reasonably estimated at this LOS					
3. WARREN/PURCHASE					
WARREN AVE EB LEFT	A/9.1	B/11.8	B/11.8	B/11.8	B/10.7
PURCHASE ST. SB	C/18.8	F/*	F/*	F/139.5	F/385.0
4. TAUNTON/SUMMIT					
SUMMIT ST. SB RIGHT	F/*	F/*	F/*	F/*	F/*
5. WARREN/EXIT 5 OFF-RAMP					
OFF RAMP SB LEFT	B/13.1	F194.7			E/44.1
OFF RAMP SB RIGHT	B/10.1	F/62.5	Signalization	Signalization	C/18.0
COMBINED	B/11.6	F/107.3			D/30.9
Note: proposed improvements at this location include signalization- see signalized results					
6. WARREN/POTTER					
WARREN AVE EB	A/8.9	B/10.7			A/7.9
WARREN AVE WB	A/7.6	A/8.4			A/8.2
POTTER ST. SB	F/204.4	F/*	Signalization	Signalization	C/16.9
FOURTH ST. NB	E/41.3	F/*			C/18.0
Note: proposed improvements at this location include signalization- see signalized results					
7. WARREN/BURGESS					
WARREN AVE WB	A/7.8	A/7.8	A/7.8	A/9.1	A/8.7
BURGESS ST.NB	B/14.3	B/14.3	B/14.3	E/47.0	E/36.4
8. TAUNTON/WATERFRONT DR.					
TAUNTON AVE WB	NA	NA	NA	E/37.3	B/13.3
WATERFRONT DR. SB				A/9.1	A/7.8
9. I-195 WB/WATERFRONT DR.					
I-195 WESTBOUND	NA	NA	NA	D/31.8	NA

* indicates that delay cannot be reasonably estimated at this LOS

TABLE 7
SUMMARY OF SIGNALIZED INTERSECTION CAPACITY ANALYSIS RESULTS
AM PEAK HOUR

		LEVEL OF SERVICE/AVG. TOTAL DELAY(Sec./Veh.)				
	SIGNALIZED INTERSECTIONS	2004 EXISTING	2030 NO-BUILD	Upgrade/ TSM Alt.	Waterfront Dr 1& 2	Vet. Mem. Pkwy
1.	**WARREN/LYON**					
	WARREN AVE. EB	A/9.4	B/11.0	B/11.0	A/9.0	B/10.4
	WARREN AVE. WB	B/19.9	F/173.4	F/173.4	B/16.7	B/17.0
	LYON AVE. NB	A/9.1	B/11.7	B/11.7	B/14.4	B/13.5
	LYON AVE. SB	A/8.0	B/14.7	B/14.7	B/10.7	B/10.0
	OVERALL INTERSECTION	B/14.0	F/82.1	F/82.1	B/13.7	B/13.8
2.	**WARREN/BROADWAY**					
	WARREN AVE. EB	F/88.5	F/204.7	F/204.7	F/93.3	D/51.1
	WARREN AVE. WB	C/33.8	E/57.3	E/57.3	D/37.1	C/26.4
	BROADWAY NB	A/9.0	B/15.2	B/15.2	B/12.0	B/13.5
	BROADWAY SB	F/143.1	F/350.9	F/350.9	F/340.5	F/443.2
	OVERALL INTERSECTION	E/63.4	F/162.6	F/162.6	F/123.9	F/132.4
2A	**WARREN/BROADWAY -w/ improvements**					
	WARREN AVE. EB			C/23.6	B/15.7	B/16.5
	WARREN AVE. WB			E/63.7	C/30.1	C/28.0
	BROADWAY NB			D/49.3	C/28.3	C/26.7
	BROADWAY SB			D/37.3	B/16.6	B/17.0
	OVERALL INTERSECTION			D/43.6	C/24.1	C/23.2
3.	**WARREN/I-195 EB OFF-RAMP (EXIT 6)**					
	WARREN AVE. EB	C/26.7	F/112.0	F/112.0	E/78.5	F/110.0
	WARREN AVE. WB	B/11.6	F/106.5	F/106.5	F/143.6	D/38.8
	SLOCUM STREET	B/15.3	C/20.0	C/20.0	C/20.2	A/0.0
	I-195 OFF-RAMP	C/28.5	F/116.9	F/116.9	F/142.1	F/108.8
	OVERALL INTERSECTION	C/21.9	F/111.1	F/111.1	F/118.7	F/88.6
4.	**I-195 WB OFF-RAMP/FREEBORN**					
	I-195 WB OFF-RAMP	D/36.6	D/40.2	D/40.2	E/66.8	D/51.0
	BROADWAY ST. NB	D/45.9	F/132.0	F/132.0	D/48.1	D/43.4
	BROADWAY ST. SB	B/18.5	C/24.3	C/24.3	B/18.1	B/17.9
	OVERALL INTERSECTION	D/35.6	E/69.2	E/69.2	D/45.2	D/38.1
5	**WARREN AVE./EXIT 5 OFF-RAMP-WITH IMPROVEMENTS**					
	WARREN AVE EB APPROACH			B/17.5	B/14.2	
	WARREN AVE WB APPROACH			A/8.2	A/7.0	
	I-195 EB OFF-RAMP APPROACH			B/19.7	B/12.0	
	OVERALL INTERSECTION			B/16.8	B/12.0	
6	**WARREN AVE./POTTER ST/FORTH ST-WITH IMPROVEMENTS**					
	WARREN AVE EB APPROACH			C/20.7	A/7.6	
	WARREN AVE WB APPROACH			D/54.6	B/16.9	
	FORTH ST NB APPROACH			F/83.4	B/19.0	
	POTTER ST SB APPROACH			F/83.4	B/11.9	
	OVERALL INTERSECTION			D/54.5	B/13.9	

Table 8
SUMMARY OF UNSIGNALIZED INTERSECTION CAPACITY ANALYSIS RESULTS
PM PEAK HOUR

UNSIGNALIZED INTERSECTIONS	LEVEL OF SERVICE/AVG. TOTAL DELAY(Sec./Veh.) 2004 EXISTING	2030 NO-BUILD	Upgrade/ TSM Alt.	Waterfront Dr 1& 2	Vet. Mem. Pkwy
1. MAURAN/VET. MEM. PKWY					
MAURAN AVE. EB RIGHT	B/14.1	F/594.6	F/594.6		
ROUNDABOUT				A/9.2	C/21.5
2. TAUNTON/WALNUT					
TAUNTON AVE. EB	B/11.5	B/12.8	B/12.8	B/13.3	B/12.6
TAUNTON AVE. WB	A/9.4	B/10.3	B/10.3	B/10.8	B/10.2
WALNUT ST. NB	F/*	F/*	F/*	F/*	F/*
WALNUT ST.SB	F/*	F/*	F/*	F/*	F/*
* indicates that delay cannot be reasonably estimated at this LOS					
3. WARREN/PURCHASE					
WARREN AVE EB LEFT	A/8.8	A/9.8	A/9.8	A/9.0	B/11.8
PURCHASE ST. SB	D/25.9	F/85.4	F/85.4	E/43.0	F/184.9
4. TAUNTON/SUMMIT					
SUMMIT ST. SB RIGHT	F/*	F/*	F/*	F/*	F/*
5. WARREN/EXIT 5 OFF-RAMP					
OFF RAMP SB LEFT	D/30.0	F/*			F/377.3
OFF RAMP SB RIGHT	A/9.6	B/14.8	Signalization	Signalization	C/16.5
COMBINED	C/24.5	F/499.5			F/184.5
Note: proposed improvements at this location include signalization- see signalized results					
6. WARREN/POTTER					
WARREN AVE EB	A/8.8	B/11.5			A/8.2
WARREN AVE WB	A/8.4	A/8.7	Signalization	Signalization	B/10.1
POTTER ST. SB	C/17.7	F/*			D/25.6
FOURTH ST. NB	E/40.7	F/*			E/35.7
Note: proposed improvements at this location include signalization- see signalized results					
7. WARREN/BURGESS					
WARREN AVE WB	A/9.1	B/12.4	B/12.4	B/11.8	B/10.3
BURGESS ST.NB	C/17.0	F/121.8	F/121.8	F/61.8	F/124.7
8. TAUNTON/WATERFRONT DR.					
TAUNTON AVE WB	NA	NA	NA	F/91.0	B/13.5
WATERFRONT DR. SB				A/9.5	A/8.6
9. I-195 WB/WATERFRONT DR.					
I-195 WESTBOUND	NA	NA	NA	E/38.7	NA

TABLE 9
SUMMARY OF SIGNALIZED INTERSECTION CAPACITY ANALYSIS RESULTS
PM PEAK HOUR

		LEVEL OF SERVICE/AVG. TOTAL DELAY(Sec./Veh.)				
	SIGNALIZED INTERSECTIONS	2004 EXISTING	2030 NO-BUILD	Upgrade/ TSM Alt.	Waterfront Dr 1& 2	Vet. Mem. Pkwy
1.	**WARREN/LYON**					
	WARREN AVE. EB	B/15.8	B/17.0	B/17.0	B/16.6	B/14.2
	WARREN AVE. WB	B/18.2	D/41.3	D/41.3	C/21.3	B/19.6
	LYON AVE. NB	A/8.8	B/13.5	B/13.5	B/19.0	B/17.9
	LYON AVE. SB	A/8.2	B/10.6	B/10.6	B/11.4	B/14.6
	OVERALL INTERSECTION	B/14.6	C/23.8	C/23.8	B/17.8	B/16.7
2.	**WARREN/BROADWAY**					
	WARREN AVE. EB	D/35.4	F/136.7	F/136.7	F/179.9	D/44.3
	WARREN AVE. WB	F/94.4	F/352.7	F/352.7	F/225.0	F/111.8
	BROADWAY NB	B/14.5	F/147.4	F/147.4	D/50.9	C/34.2
	BROADWAY SB	F/144.8	F/473.9	F/473.9	F/292.1	F/417.7
	OVERALL INTERSECTION	F/85.0	F/308.7	F/308.7	F/209.6	F/175.4
2A	**WARREN/BROADWAY -w/ improvements**					
	WARREN AVE. EB			B/17.6	B/16.3	B/17.3
	WARREN AVE. WB			C/28.7	D/38.8	C/29.8
	BROADWAY NB			C/24.2	D/42.6	C/33.2
	BROADWAY SB			C/21.2	C/34.1	C/20.5
	OVERALL INTERSECTION			C/26.1	C/34.0	C/25.0
3.	**WARREN/I-195 EB OFF-RAMP (EXIT 6)**					
	WARREN AVE. EB	C/21.8	D/48.6	D/48.6	D/38.5	D/43.2
	WARREN AVE. WB	B/10.7	D/44.4	D/44.4	E/64.6	C/23.2
	SLOCUM STREET	B/11.6	B/18.9	B/18.9	B/15.7	A/0.0
	I-195 OFF-RAMP	C/21.4	E/61.7	E/61.7	E/63.3	D/51.6
	OVERALL INTERSECTION	B/18.2	D/50.9	D/50.9	D/54.8	D/39.7
4.	**I-195 WB OFF-RAMP/FREEBORN**					
	I-195 WB OFF-RAMP	D/35.4	F/363.2	F/363.2	E/64.9	D/52.4
	BROADWAY ST. NB	C/23.3	F/152.6	F/152.6	E/69.7	E/61.5
	BROADWAY ST. SB	B/16.5	C/22.8	C/22.8	C/32.8	C/34.6
	OVERALL INTERSECTION	C/26.9	F/215.0	F/215.0	E/58.4	D/51.0
5	**WARREN AVE./EXIT 5 OFF-RAMP-WITH IMPROVEMENTS**					
	WARREN AVE EB APPROACH			D/35.8	C/28.2	
	WARREN AVE WB APPROACH			A/5.3	A/6.4	
	I-195 EB OFF-RAMP APPROACH			D/52.2	C/34.8	
	OVERALL INTERSECTION			D/37.1	C/28.2	
6	**WARREN AVE./POTTER ST/FORTH ST-WITH IMPROVEMENTS**					
	WARREN AVE EB APPROACH			C/25.3	B/12.5	
	WARREN AVE WB APPROACH			C/30.5	C/29.1	
	FORTH ST NB APPROACH			D/39.1	D/37.0	
	POTTER ST SB APPROACH			D/39.2	B/13.4	
	OVERALL INTERSECTION			C/30.2	C/23.0	

Freeway Capacity Analyses

The various components of I-195 within the study area were analyzed in terms of capacity. The components included freeway segments, ramp junctions and weave sections. The analyses were conducted for the 2004 existing traffic volumes, the projected 2030 No-Build Condition, and the three build alternatives.

Freeway Segments

A basic freeway segment is the portion of freeway that is not influenced by ramps and/or weaving sections. The operations of a freeway segment are measured by the density, expressed as passenger cars per mile per lane (pc/mi/ln), speed and volume-to-capacity ratio. Although drivers often rate their freeway service by the speeds at which they drive, the proximity of other vehicles and the ability to move between lanes are also measures of comfort, and these variables can be assessed by density. Refer to Table 10 for the freeway LOS criteria.

Table 10
Summary of Freeway Level of Service Criteria

Level of Service	Freeway Segment Density Range (pc/mi/ln)	Weaving Segment Density Range (pc/mi/ln)	Ramp Merge/Diverge Density Range (pc/mi/ln)
A	0-11	< or =10	< or =10
B	>11-18	>10-20	>10-20
C	>18-26	>20-28	>20-28
D	>26-35	>28-35	>28-35
E	>35-45	>35-43	>35
F	>45	>43	Demand exceeds capacity

The LOS results of the freeway segment capacity analyses are shown in Table 11.

Table 11
Summary of Freeway Capacity Analyses
Level of Service - Density (pc/mi/ln) - Mean Speed (mph)

	2004 Existing Condition			2030 No-Build & Upgrade/TSM Alt.			2030 Build Waterfront Drive 1			2030 Build Waterfront Drive 2			2030 Build Vet. Mem. Pkwy		
	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed
AM PEAK HOUR															
Freeway Segments															
I-195 EB between Exit 4/5 and Exit 6	C	23	60	F	*	*	F	*	*	F	*	*	F	*	*
I-195 WB between Exit 4/5 and Exit 6	D	30	60	E	37	56	E	39	55	see weave analysis			see weave analysis		
Diverge Analyses															
I-195 EB Exit 4 off-ramp	C	21	53	F	41	46	F	40	46	F	40	46	F	35	47
I-195 EB Exit 5 off-ramp	C	26	56	E	39	51	E	39	51	E	39	51	E	37	51
I-195 EB Exit 6 off-ramp	C	27	55	F	42	53	F	43	53	F	43	53	F	43	53
I-195 WB Exit 4/5 new off-ramp	-----	-----	-----	-----	-----	-----	E	38	55	see weave analysis			see weave analysis		
I-195 WB Exit 6 off-ramp	C	28	51	D	34	50	D	32	51	D	32	51	D	32	51
Merge Analyses															
I-195 WB Exit 6 on-ramp	D	29	53	D	33	52	D	34	51	see weave analysis			see weave analysis		
I-195 EB Exits 4/5 New On-ramp	-----	-----	-----	-----	-----	-----	F	43	44	F	43	43	F	42	45
Weaving Analyses															
I-195 WB between Exits 4 & 3	F	69		F	66		F	64		F	64		F	58	
Weaving Segment Speed			34 mph			34 mph			34 mph			34 mph			35 mph
I-195 WB btw. Exits 6 & New Ramp at 4/5	-----	-----	-----	-----	-----	-----	-----	-----	-----	D	35		E	37	
Weaving Segment Speed												48 mph			44 mph

* Indicates that density and speed could not be estimated at this LOS.

Table 11 -continued
Summary of Freeway Capacity Analyses
Level of Service - Density (pc/mi/ln) - Mean Speed (mph)

	2004 Existing Condition			2030 No-Build & Upgrade/TSM Alt.			2030 Build Waterfront Drive 1			2030 Build Waterfront Drive 2			2030 Build Vet. Mem. Pkwy		
	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed	LOS	Density	Speed
PM PEAK HOUR															
Freeway Segments															
I-195 EB between Exit 4/5 and Exit 6	D	32	59	E	43	53	F	*	*	F	*	*	F	*	*
I-195 WB between Exit 4/5 and Exit 6	C	21	60	F	*	*	F	*	*	see weave analysis			see weave analysis		
Diverge Analyses															
I-195 EB Exit 4 off-ramp	F	29	52	F	32	47	F	33	47	F	33	47	F	31	48
I-195 EB Exit 5 off-ramp	D	34	55	D	33	51	D	33	51	D	33	51	D	33	52
I-195 EB Exit 6 off-ramp	D	34	55	E	38	54	F	40	54	F	40	54	F	41	53
I-195 WB Exit 4/5 new off-ramp	-----	-----	-----	-----	-----	-----	F	41	54	see weave analysis			see weave analysis		
I-195 WB Exit 6 off-ramp	C	24	51	E	38	50	E	37	50	E	37	50	E	37	50
Merge Analyses															
I-195 WB Exit 6 on-ramp	C	21	55	E	37	50	F	38	49	see weave analysis			see weave analysis		
I-195 EB Exits 4/5 New On-ramp	-----	-----	-----	-----	-----	-----	F	38	48	F	38	48	F	39	48
Weaving Analyses															
I-195 WB between Exits 4 & 3	E	40		F	51		F	60		F	60		F	59	
Weaving Segment Speed			40 mph			40 mph			37 mph			37 mph			37 mph
I-195 WB btw. Exits 6 & New Ramp at 4/5	-----	-----	-----	-----	-----	-----	-----	-----	-----	E	39		F	43	
Weaving Segment Speed												48 mph			44 mph

* Indicates that density and speed could not be estimated at this LOS.

Freeway Weaving Segments

A freeway weaving segment is the portion of freeway in which two or more traffic streams traveling in the same direction must cross paths without the assistance of traffic control devices in order to proceed in their desired route. Weaving segments occur when a merge area is closely followed by a diverge area. For a weaving segment to occur when a merge ramp is followed by a diverge ramp, an auxiliary lane must run between the two. The density ranges for the LOS are presented in Table 10. The results of the weaving analyses applied to this project are shown in Table 11.

Ramp-Freeway Junctions

Ramp-freeway junctions represent the portions of freeway upon which the entering and exiting maneuvers take place. Ideally, on-ramp traffic merges into the freeway traffic stream and off-ramp traffic diverges out of the freeway traffic stream without disruption to the freeway traffic. Similar to freeway segments and weaving segments, the LOS of a freeway-ramp junction is defined the density as indicated in Table 10. The results of the capacity analyses for freeway-ramp junctions on this project are shown in Table 11.

Comparison of Capacity Analysis Results

Figures 29 through 38 show the calculated LOS throughout the project study area in the AM and PM peak hours under the 2004 existing conditions, the 2030 No-Build Conditions and under the three build alternatives. The capacity analysis results are also summarized in the previous tables.

The initial comparison is between the peak hour traffic operations of the 2004 Existing Conditions and the 2030 No-Build Condition. The analysis of existing freeway operations shows LOS primarily in the range of “C” or “D”. However, drivers on I-195 in the peak periods today often experience long delays due to residual back-ups on I-195 that begin in Providence and delays due to the weaving section and diverge near Exits 4. The additional traffic anticipated on the freeway by 2030 brings the LOS of the various freeway segments down to LOS “E” and “F” in the peak hour conditions. Similarly, the intersections along Warren Avenue deteriorate in LOS from 2004 to 2030, with a few intersections reaching LOS “F” in the 2030 peak periods.

The results of the capacity analyses for the build alternatives were compared to the results for the 2030 No-Build Condition. All three build alternatives showed improvements to the LOS at major intersections along Warren Avenue en route to Exit 6. LOS improved from LOS “F under the No-Build Condition to LOS “B”, “C”, and “D” depending on the exact location. Intersection improvements have been developed for some of the Warren Avenue intersections

and are included in the build alternatives. These intersections include Warren Avenue/I-195 EB off-ramp, Warren Avenue/Potter Street and Warren Avenue/Broadway.

As for the freeway operations, the build alternatives did not significantly alter the projected LOS along the freeway. The freeway is expected to operate at or below capacity by 2030. The inclusion of two additional ramps does not alter the overall operation projected along the freeway. While there were some specific locations with an increase or decrease in LOS, overall, the freeway operations are poor in 2030 under the No-Build and Build Conditions.

3.6 Comparison of Alternatives

The proposed project alternatives have been analyzed in terms of traffic operations for the projected life span of the improvements. The No-Build alternative serves as a baseline comparison.

The Upgrade/TSM Alternative improves the current route to and from I-195 to the east from the western portion of East Providence. This alternative offers intersection improvements and additional capacity on a portion of Warren Avenue in one direction. Overall, the Upgrade/TSM alternative does not greatly alter the current traffic operations or improve access to and from the east. By providing new ramps at the I-195/Taunton Avenue/Warren Avenue Interchange, the build alternatives do improve access to and from the east. In addition, the build alternatives provide relief to the major arterials in East Providence that currently carry traffic en route to I-195 to the east.

Waterfront Drive 1 and Waterfront Drive 2 are identical in terms of projected traffic assignments. The traffic operations are essentially the same under these two alternatives, with minor differences on the freeway in the vicinity of the new proposed I-195 WB off-ramp. The new proposed ramps to and from I-195 to the east are projected to carry higher volumes of traffic than under the Veterans Memorial Parkway alternative.

The Veterans Memorial Parkway alternative achieves more in terms of improving access to and from I-195 to the east when compared to the Upgrade /TSM alternative and slightly less when compared to the Waterfront Drive alternatives. Traffic circulation is somewhat more complicated under this alternative, since access to the new ramps is achieved via Veterans Memorial Parkway.